



# *Water and Ethics*

A HISTORICAL PERSPECTIVE

*Fekri A. Hassan*



UNESCO International  
Hydrological Programme



World Commission on the Ethics of  
Scientific Knowledge and Technology



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# Preface

This essay is one of a series on Water and Ethics published under the International Hydrological Programme of UNESCO. A Working Group on the Use of Fresh Water Resources was established under that programme in 1998. Preliminary drafts on fourteen aspects of this topic were prepared under the guidance of this Working Group.

An extended executive summary was prepared by J. Delli Priscoli and M. R. Llamas and was presented to the first session of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) held in Oslo in April 1999. At the latter meeting, COMEST established a sub-commission on the Ethics of Fresh Water under the Chairmanship of Lord Selborne. The first meeting of this sub-commission was held at Aswan in October 1999. A 50-page survey by Lord Selborne on the Ethics of Fresh Water, based on the above meetings and documents, was published by UNESCO in November 2000.

Since then, the original draft working papers have been revised under the editorship of James Dooge and published on CD ROM as an input to the Third World Water Forum held in Kyoto in March 1993. These are now being published in printed form as the first fourteen titles in a series of Water and Ethics

These essays are written from the point of view of experts on different aspects of the occurrence and use of fresh water who are interested in the ethical aspects of this important subject. They do not purport to be authoritative discussions of the basic ethical principles involved. Rather, they aim at providing a context for a wide-ranging dialogue on these issues between experts in diverse disciplines from the natural sciences and the social sciences.

James Dooge  
John Selborne

This essay reviews the ethics of freshwater use in a historical perspective as a background to our current problems. It covers in outline the interaction between water use and the development of civilisation from the advent of agriculture through the development of state action and of cities, and from the rise of ancient civilisations to the emerging global society.

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# 1. Synopsis

The call for examining the ethics of the uses of freshwater resources stems from the perception that current freshwater resources of the world are dwindling and that a large number of people in the world have no access to safe water. In addition, there are conflicting demands for water among different users within and between nations which threatens social and international security, peace, and stability.

From a historical perspective, the current situation is a product of social, economic, and ideological developments attending the advent of industry about two hundred years ago. Industrialisation was accompanied by certain trends that have led to an unprecedented increase in water consumption; (1) greater needs of industrial production, (2) an expansion in world population, (3) an explosive rate of urbanisation, and (4) a pronounced increase in ecological impact, including changes in landscape, pollution, and depletion of certain resources.

These changes occur in a social environment characterised by a global rift between a few affluent industrial nations and many countries in Africa, Asia, and Latin America. Many of these countries were colonised by European powers; a phenomenon which has led not only to the marked disparities in wealth, but also in the potential for growth and development.

The overriding ethos of the industrial powers was wedded to a western model of nationalism that has been instrumental in fostering notions of national distinctions based on race, geography, or ideology. Industry has also nurtured a faith in technological fixes and an ethos of profit. The current tendency to solve the challenges facing humanity from the current industrial ethos by recourse to technological fixes, pricing policies, and market economies are both misguided and insufficient. The current situation has been precipitated in the first place by such policies over the last two hundred years.

The current crisis will be aggravated by a continuation of explosive rates of population increase, urbanisation, and consumption in the foreseeable future (20–40 years), even if current rates are to slow down. In addition, the remarkable economic growth of rich, industrial countries will not get very much greater and that of the poorer countries will get a little greater, but also not much greater. The reason for the slowdown is primarily that as a society gets richer, its labour force moves increasingly into occupations where increase in productivity is more and more difficult, such as service trades, government, education, medicine and so on. Agriculture and manufacturing are an ever-declining part of the economy. Moreover, the remarkable growth of the industrial nations until the 1960s was in part due to high returns from investments which are now diminishing as it becomes more costly

to get raw materials and the cost of labour increases. Access to education and information has led to great expectations by an ever increasing number of people. The current crisis, is also made worse by a weakening of the nation-state as an economic force, and its replacement by trans-national institutions from the world bank to the multi-national corporations, and a dissociation of the place of production from that of the finance, with the consequence that money-making is not community-based.

As such, the current predicament is a result of a fragmentation of management and a marketing ethos that regards everything as a commodity, and profit as the ultimate objective. Our past has been marked by several transitions to overcome similar bottle necks in our evolutionary trajectory. The scarcity of water resources was already experienced by our prehistoric ancestors as droughts accompanying the shift to a post-glacial climate 14,000 to 10,000 years ago. The world population was then no more than 10–12 million people. The use of new food technologies, mostly farming has since then led to a remarkable increase in world population, the development of large cities and towns, and commercial economic systems have ultimately led to the emergence of industry. These developments were associated with a change in management and social organisation, which included the rise of early state societies, city-states, and more recently the nation-state. The enhancement of water and food security in response to endemic fluctuations in production and occasional external factors (e.g., droughts) led to an aggrandisement in the size and complexity of the organisational unit. Large units incorporated peoples from different regions and backgrounds, as well as different occupational groups. Such units could only be sustained by integrative ideologies and ethics of social justice.

In the emerging global context of the modern crisis, concentrated control over production and marketing in the hands of a few giant multinational companies means that they capture the majority of the profits and control prices. Today, such corporations are creating a polarized global economic system in which they would exercise integrated control over all stages of production and marketing, and like oil companies, will be able to manipulate supply and prices on a world-wide basis through monopoly practices, and control over international financial and managerial institutions. Multinational corporations and financial institutions also undermine the managerial powers of the nation-state, and erode current modes of national and international stability (Huntington, 1973; Korten, 1995). It is indeed essential to redress the current situation for multinational corporations, as some are already doing, to recognize the need for long-term strategic thinking (Schmidheiny, 1992), and to take into consideration the danger to their economic interests of widespread dissent, demoralizing poverty, and disabling weak educational infrastructures in the Third World. Paradoxically, globalization has been associated with the mushrooming of separatist movements. We are thus faced not only with a water crisis, but with a

managerial crisis as well. The disintegration of 'conventional' integrative social mechanisms threatens to undermine the political stability of both rich and poor countries alike. The institution of a global managerial strategy cannot be achieved without the adoption of the enduring principles of justice and hope. In the past, the oppressive and tyrannical monopolies of the ruling elites were tempered by notions of social justice, compassion, and morality. From 500 BC to 700 AD, such notions became incorporated in world religions that still serve as the basis of ethics for the majority of the world. The moral principles of justice have also led in modern times to humanistic notions of equity and human rights. No society is sustainable if its integrative ideology is based on threats, coercion, or deception, and no society is viable if the masses who are the producers of wealth to the elite are bereft of hope.

At this juncture, fragmentation of water management is the principal culprit. From a historical perspective, what is needed is an integrative ethic of water management, which deals with local problems of water availability as a function of water resources, transportation, distribution, and consumption in a trans-regional and global context. First, it is important to transform the mode of management from one of technical fixes to a mode of community management. This means that people must be informed and included in making decisions. Engineers need the support of society for the achievement of their technical operations. In fact, the choice and scale of such operations depends ultimately, if it is to succeed, on a social agenda. Although there has been a significant appreciation of the participation of communities in hydraulic engineering projects over the past 50 years, engineers need to explore a new relationship with people and the education and training of engineers should emphasise this (Newson, 1992).

Choices will have to be made about rates of consumption, wasteful practices, recycling, and other solutions. Different users, policy-makers, financial agencies, and professionals have to come together to exchange information and to achieve trust, promote accountability and transparency. This managerial strategy involves top-down and bottom-up approaches in a meaningful exchange of information and clarifications of the basis for making certain decisions, as well as a collective consideration of alternate solutions.

Secondly, the technical aspect of a holistic managerial mode must go beyond a conventional constructional engineering approach to an environmental engineering with a consideration of the relationship between water works and the viability of local, regional, and global ecological regimes (e.g., impact on surface erosion, groundwater table, micro-climate, land-use).

Thirdly, technical aspects should not be restricted to large, hi-tech projects because such projects are often expensive, and can be ecologically harmful. Consideration must be given to small, even household or community projects that can be under-



taken using local materials, local labour, and traditional know-how using successful examples from various parts of the world which are still operative. Some of these traditional methods might have been pushed aside by modern technology and may be reconstructed from historical or archaeological investigations. Traditional water works may be mixed with hi-tech electronic or biotechnological innovations to enhance their efficacy and benefits.

Fourthly, an emphasis must be placed on broadening the scope of management to include the social dimension of water resources development and management. This will necessitate the active participation of anthropologists, sociologists, historians, and archaeologists to consider and evaluate the social impact of projects on local populations, cultural heritage, and the ways by which local cultural traditions can facilitate, legitimate, and support efforts to deal with water supply, water demand, distribution, consumption, and waste management.

Fifthly, water management in a global context in order to achieve a modicum of stability within and between nations and to guarantee sound trans-national co-operation must be based on exchange of benefits and cost-sharing on the basis of financial capabilities, educational competence, labour and technological aptitudes. The aim of co-operation should not be short-term profit, but long-term global sustainability of ecological resources and mutual support. Exchange of benefits may not be restricted to water or manufactured goods but may include ecological preserves, access to cultural heritage sites, religious locations, health resorts, sacred landscapes, as well as tourist and recreational locales. If water is to be considered, at least in part a commodity, such landscape elements must be given an 'economic' value to be fairly exchanged for water, food, or manufactured goods. Inter-governmental policies to guarantee equity in economic exchanges should be set up to establish fairness in the value of 'landscapes', labour, manufacture, and services. Without a fair exchange, the world will continue to suffer from the malaise of inequity and despair that leads to anomie, revivalist movements, escape from reality, violent confrontations, and suicidal undertakings.

Sixthly, the ethics of equity, community participation, and social management integrating local, regional, and global elements to sustain society and the human habitat, must be combined with an ethical criteria for establishing priorities. Given limited financial and labour resources, both on a global and a local scale, decisions must be undertaken on the basis of feasibility, urgency, tolerable levels of economic and social cost relative to social, political, economic, and ecological benefits. Desalination may be the most satisfactory solution in one situation, but rainwater harvesting may be optimal in others. To waste money and effort on a single technology, that may be successful in a particular setting, in another situation where social factors might not be favourable for its acceptance or sustainability is unethical.

It is also fair to assume that advances in electronic and biotechnological innovations which may be beneficial in many world situations should be sponsored and funded by affluent nations and international agencies. Such innovations should not be distributed at cost or at a subsidy to those who cannot afford it, since the benefits from their usage in water savings, improving water quality, and renewing supply is necessary for political and ecological security.

Scarcity at present and in the past has been a question of water availability, where and when it is needed, and not on the basis of global averages. However, scarcity of commodities has also been in the past a means for generating profit for an privileged few, who (1) controlled the source of raw material (in this case water), (2) those who processed it into another usable form, and (3) those who traded it. Indeed, scarcity is in many cases a *product* of pricing. Moreover, pricing will provide benefits from those who can afford to buy water. Competitive pricing and a limited supply means that the poor who cannot at present afford the inflated prices of food, will soon be unable to afford the price of a drink of water (many of them already do not), and will also have to pay even more for food, since its price, as *virtual* water, will also increase on the basis of the market price for water.

Water, least we forget, is one of our enduring human symbols of life, regeneration, purity and hope. It is one of our potent links with the sacred, with nature, and with our cultural inheritance. This is our opportunity to bring water forward as a medium for a global project that unifies humanity in a single cause for peace, stability, amity, and ecological sustainability. The healing powers of water, the simple pleasure of drinking pure water, and the awesome power of waterfalls have the potential of bringing us together as one with each other and as one with nature.

## 2. Introduction

The call for a water ethic has become fundamental to our contemporary formulations of an effective policy of water management. International conflicts over water are a matter of grave concern in many parts of the world. At present, no less than 2.3 billion people live in water-stressed areas (where water supply is less than 1,700 cubic meters per year). If current trends continue, water stress will affect 3.5 billion, almost half the world's projected population in 2025 (*UNESCO Courier*, October 2001). Water shortages are currently afflicting both developed and underdeveloped countries, with the impact more severely felt in Sub-Saharan Africa where 48% have no access to safe water, South Asia where the figure stands at 35% (*UNDP Human Development Report 1998*). Every day 34,000 people die from water-related diseases. These are alarming figures for anyone who cares. In an interview at the eve of the Ninth Water

Conference held in Montreal in 1997, Elisabeth Dowdeswell, the executive director of the Nairobi-based UNEP (United Nations Environment Program), concluded that 'At the end of the day, the issues are essentially ethical ones – how people care for their fellow human beings' (report by Doug Sweet, *The Gazette*, Montreal, September 4, 1997). Federico Mayor, in a recent *UNESCO Courier* editorial commenting on the grave risk of fresh water scarcity 'But if the outlook is gloomy, crisis is not yet inevitable, on condition that we do three things: put technology back in its place, recognize both the possibilities and limitations of the market; and above all give priority to a new "water ethic"' (*UNESCO Courier*, February 1999).

The situation is severely aggravated by the rampant pollution of our fresh water resources, which has led Sandra Postel to call for a water ethic that makes the protection of water ecosystems a central goal in all that we do (Postel, 1997). It is astounding that our demand for water over the last century has risen sevenfold, while the world population has increased three-fold over that period. The global water landscape consists of diverse local situations. For example, with a minimum requirement of, say, 150 litres per family, the average in Africa is 20 litres compared with 350 in Canada and 165 in Europe. There are also glaring variance in demands for different water uses in different countries and regions. There are also dramatic differences in available water resources.

Our current predicament is a result of our recent past, and is complicated by a variety of notions concerning the 'value' of water, which belong to different cultural and historical situations. Therefore, the call for a 'new' water ethic requires, if it is to become socially instituted, a consideration for its social and cultural history. As Gustafson remarked in an essay on the 'Ethical issues in the human future', cultural activity, including moral activity, begins in response to what is occurring, what has been received from the past, what impinges upon persons and societies.

The 'water crisis' is only one of many problems that we face today as we move to a global order marked by a set of interrelated threats to human life both in rich and poor countries. These threats include the population explosion, a sharp increase in urbanisation, an acceleration of rates of consumption, and an attending proportional increase in our impact on the planet. Although, the industrial revolution has led to a demographic transition toward a small family size in Europe, it has fostered an unprecedented population increase in poor countries. Although there is a marked reduction in the *rate* of population increase, the population of poor countries will still double in 30–40 years. In addition industrialisation and the expansion of the managerial sector has led to an increase, equally unprecedented in the size of urban settlements and the ratio of urban to rural dwellers. The concentration of people in settlements that now may number more than 10 million persons, as well as the concentration of industrial activities places heavy demands on local

resources and leads to a deterioration and in some cases irrevocable damage to local resources.

In this essay I endeavour to place our recent past in its proper, long-term historical perspective. I contend that at present, our common global civilisation is shaped by notions of a powerful elite, including professionals, who believe in the emancipating role of technology and market economy. The visions of many people in the world today are also embedded in notions of exclusionary nationalism. These visions are a product of the hegemony of an industrial mode of civilisation which had for the last two hundred years been responsible for altering our relationship with nature, introducing unprecedented models of political and social organisation, and an ethos that valorises individualism, competition, profit, and material success. The industrial transformation was relatively rapid and sweeping. It has intensified our impact on the planet, and had led to spectacular achievements in transportation and communication. This had the effect of creating one world divided by an economic chasm. The rich industrial giants, benefiting from their gains at a time when Europe was a major colonial power, are now in a position to leap to a new level of global dominance based on services and information technology, while many other countries are still struggling to eke a living.

## 3. The emergence of settled society

### 3.1 *The advent of agriculture*

The transition to warmer climate heralded unstable weather conditions, which in turn influenced the availability, quality, and distribution of plant and animal communities. In a broad area from Anatolia in Turkey to the Sahel in northeastern Africa, hunters, foragers, and fishers began to pursue specialised activities or broaden their range of subsistence activities. Innovations in tool-making and hunting gear, and in many other areas of human life were already happening since our own immediate ancestors (*Homo sapiens sapiens*) became a successful species. The human creativity of our young species was put to the test during the unstable conditions at that distant episode of climatic change from 16,000 to 8,000 years ago. Among the variety of inventions and developments, horticulture and the domestication of cows, sheep, goats, and pigs proved to be the most revolutionary.

In a span of five thousand years, farming villages spread like bush fire into many parts of Europe, Asia, and Africa stimulating further developments in domestication and management of plants and animals. Nomadic pastoralism also emerged as a

successful strategy, often in a symbiotic relationship with settled farmers. But it was settled farming, especially in river basins, that set the stage of great and spectacular developments in the next phase of humanity.

Farming in the floodplains of great rivers provided the essential ingredients for sustainable farming, as well as the potential for economic and population expansion. Floodplains are naturally irrigated by floods. Arable land is also abundant and extensive.

The story of settlement along the banks of rivers by farming communities has been repeated over and over again in many places all over the world. Rivers also provided opportunities for corridors of population movements and colonisation from primary areas of occupation. The floodplains of rivers also constituted refugee areas during droughts: floodplains were the incubators and the nurseries of civilisation.

The relationship between rivers and civilisation cannot be properly considered without taking into account the layout (geomorphology) of floodplains, and the dynamic relationships between floodplain landscape and variation in flood discharge. In general, rivers with an erratic, intermittent flood discharge, in mountainous regions with a coarse-grained load of sediments, are characterised by channels with narrow strips of overbank sediments. Moreover, the channels are continually shifting in response to erratic flood discharge creating a landscape of braided streams. By contrast, rivers or stretches of rivers in low-relief areas, plains or basins, with a steady water influx, and a fine-grained load of sediments, are characterised by broad floodplains and meandering channels. It is on the floodplains of these meandering rivers that many civilisations were sustained. Climatic changes which cause variation in floodwater discharge can alter the dynamics and character of alluvial (riverine) landscapes. People are likely to adjust to a changing floodplain landscape because it may affect the size of the arable land, the amount of water delivered to their fields, the accumulation of soil, the height of the water table, the renewal of soil and proximity to other riverine resources.

Construction of canals for irrigation is one of the responses to ensure the flow of water to previously established field plots that may suffer under starvation, or to supply outlying areas with irrigation water. This may be caused by a need to stabilise the economic base at times of water shortage, meet the demands for greater production, or to provide more revenues to a wealthy elite. Shifting political conditions and developments of novel patterns of social organisation are as much a part of the history of alluvial landscape as variation in water discharge. Floodplains have been altered over the last five thousand years in a variety of ways by irrigation and drainage canals, dams, and barrages, embankments for protection from large floods, reclamation of marshlands, and development of waterways and locks. Responding to

their particular local conditions, and the historical cause of events along their banks, rivers in different parts of the world have their own peculiar landscape.

Along the banks of the River Nile, the verdant green fields and the bountiful food resources of Egypt depended on the fertile soil of the Nile flood plain and the annual summer flood, which commenced in the middle of June and lasted until the middle of October. The River Nile is a meandering stream with a rich supply of fine-grained silt brought down from the Ethiopian highlands – the floodplain is higher in elevation close to the channel where rising floodwaters drop their sediments as their energy is dissipated. Farther away toward the outer margin of the floodplain, where deposition is limited, there is a noticeable drop in elevation. Pools from floodwater seepage are characteristic of the outlier. Levees, ridges of sand and silt, border the deep and concave side of the meanders providing the potential for harbours and ports. Pools left behind after the flood receded provide a rich harvest of fish. Tall trees along the levees are the major source of wood. Floodbasins in the central sector of the floodplain, well-drained, with fertile silt, and a reliable source of water during most years, provide the best arable land. Close to the river the floodplain suffers from too much water, and farther away at the outer edge the floodplain water is only available when large floods occur.

Egyptian agriculture was primarily based on the cultivation of emmer wheat and barley. Both provided the staple food for Egyptians who made bread and cakes from cereals. Because of its greater resistance to water shortage and salinisation barley was more common. The predominantly cereal diet was supplemented by *fava* beans, lentils, and peas which were a good source of plant proteins. Lettuce, cucumber, onions, radish, and leeks were cultivated as favourite vegetables. The Egyptians also cultivated and collected a wide variety of medicinal herbs. Fruits from orchards included melons, dates, sycamore figs, grapes, and pomegranates. Farmers also kept sheep, goats, cattle, and pigs. Cow herders in the Delta made use of the marshes and wet lands (Bowman and Rogan, 1999).

Events in Mesopotamia, another cradle of civilisation, as those in ancient Egypt, have become an integral element of our cultural memory because they have become embedded in the religious texts of Judaism, Christianity, and Islam. Both the 'Flood' and the 'Seven Years of Drought' are still memorable events.

In this land between the rivers (*Meso*, between, *Potamia*, rivers in the Greek name of Sumer and Akkad), the lands of Sumer and Akkad are distinct. Boxed by natural frontiers, the alluvium is deep and sufficiently flat and broad. The floodplain was continually shaped and reshaped. Along the banks of the river, deposits accumulated fast as the energy of floodwater was rapidly dissipated when water overtopped the river banks. These levees were also made of sand and coarse silt with good drainage supporting a gallery forest of willows, poplars and liquorice before the natural

landscape was modified by farmers. Farther away from the channel over the broad, flat floodplain, finer sediments accumulated from slow-moving floodwater forming layers of alluvial mud. Between the floodplains of the two rivers, beyond the reach of floodwater a broad strip of barren desert remains until today a refuge for hyenas, jackals, eagles, lions, and gazelle. Shifting belts of sand dunes in the floodplain and the deserts along the outer edge of the floodplain is a reminder of the life-giving gift of the rivers.

Unlike the narrow floodplain of the Nile Valley, the Sumerian floodplain is much broader providing the potential for canal irrigation. Dependence on riverine water does not seem to have been the case during the emergence of agriculture in Mesopotamia, Anatolia, or the Levant. However, as people began to depend on farming as the primary source of their livelihood, the recurrence of droughts was most likely the prime mover for occupation of the riverine floodplain and eventually the development of floodplain irrigation (Postgate, 1992).

Of the two rivers, the Euphrates seems to have been favoured by the early settlers because its floods were less hazardous and its soil somewhat more fertile. The levees with access to water and natural drainage were ideal for orchards and gardens, the flood basins were more suitable for cereal grasses. Land use, as we may surmise from a record of land surveyed in Girsu under the reign of Sulgi recognises orchards as a special category. Other arable land is divided in terms of productivity (which depends on proximity to channel) as flooded, good, middling, medium, and poor. Middling land can be either in use, empty (fallow) or occupied by grass (presumably as a result of salinization). Badland can be also identified as a land, ploughed but grain did not grow. Land reclaimed is 'good, brought out of the water'. This is most likely land close to the channel, which has been brought out of the floodwater by the digging of drains. Wells, mentioned in the record, were required at times of seasonal or episodic droughts. Dykes, also mentioned, were for protection and for controlling the flow of water, as were canals, which were also in the record. Canals were run parallel to the channel to ensure a water supply as water will flow rapidly in the main channel, except for overbank flow. Water may then be siphoned off the canals into distributary feeders. Outlets or sluices opened in the sides of the bank of canals served this function. Water-check dams (regulators) of reeds and mud, and more elaborately from backed bricks, were used to retard water flow and raise water level behind them so that water level would rise to the level required to water the adjoining fields. The accumulation of silt in the fields if it occurs faster than deposition of silt in the canal can deprive the fields from water necessitating dams or an increase in their height. Dams would have also been required to provide greater water supply which may be needed to irrigate a larger area than previously cultivated.

The Tigris and Euphrates flow from the northern highlands to the south building

an alluvial plain before they drain into the Persian Gulf. The floodplain consists of river basins and higher levees, which create a maze of distinct arable plots that can hardly be appreciated by looking at large-scale maps. The variable flow of the rivers has been responsible for major shifts in the position of distributary channels, as well as variations in the sinuosity of their meanders. With the development of settled villages, advantageous for storage and protection, it was more reasonable to attempt to stabilise the landscape by collaborative efforts to construct earthen banks and dig feeder canals.

Another example of an early agrarian civilisation is India, where farming villages developed more than 7,000 years ago cultivating wheat and barley, and raising sheep, goats, and cattle, a package developed earlier in Mesopotamia. Cultivation and herding spread into Europe, North Africa, including the Nile Valley, and India from Southwest Asia and Anatolia perhaps as a result of trade colonies, dissemination of ideas, and the occasional movements of farmers and herders in search of land or pastures, especially at times of droughts as happened in 7,500 and 6,000 years before the present time. By 5,000 years ago, as in Egypt, towns emerged in the Indus Valley with palaces, temples, and fortifications. Between 4,500 and 4,000 years ago, the Harrapan civilisation, named after Harappa in Punjab, reached its zenith with burgeoning population, well planned cities, and brisk trade with Mesopotamia (Possehl, 2002).

## 3.2 The origins of the state

The need to overcome food shortages induced by variations in rainfall or riverine water flow led to the emergence of a complex system of food storage, food exchange, and food processing. The anxieties resulting from occasional famines were remedied by both technical fixes to increase food security and by ritual and cognitive strategies that aimed to seek the intervention of higher natural, cosmic, or metaphysical powers to alleviate anxiety and the sense of uncertainty. Already tension and conflict generated by crowding together on a year-round basis had paved the way to the emergence of mediators empowered by shamanistic powers. Mediators connected to the supernatural world were also in a position to assume the role of mediation between the farmers and the world of spirits, ghosts, and deities. The mediators soon evolved into chieftains and kings commanding a large number of communities. As more communities were joined together in a single economic unit, they were able to help each other in overcoming local food shortages. Eventually, the political units extended beyond the range of kinship ties, creating state societies governed by kings. The rule of kings was legitimated by cosmogonic theologies emphasising the divine



origin of kingship. Kings also won the allegiance of local chiefs by a system of rewards from revenues collected locally and transmitted to the king.

In Mesopotamia, following a period of approximately two thousand years of agricultural life, the transition to a state society is marked by the appearance of cities, centres of major population aggregates, distributed widely across the southern plain. These were centres of strong local identities clearly marked by their allegiance to local deities. Temples were the central landmark of the emerging city states (Pollock, 1999). In Egypt, towns and temples also characterised early state societies. However, the linearity and relative circumscription of the Nile Valley, as well as navigation along the Nile facilitated the emergence by 3000 BC of a 'nation' state, unifying farming communities in southern Egypt and the Delta (Kemp, 1989) .

The emergence of state societies marks a major transition in the history of humankind. It was associated with the establishment of a power landscape. Pyramids, like mountains, temples with great columns and majestic halls, ziggurats rising as no human building ever did before, were becoming a familiar scene by four thousand years ago from the banks of the Euphrates to the valley of the Yellow River in China. The great monuments were an expression of a new landscape – a landscape of power vested in kings and priests. The transition to a state society creates a cultural order based on a hierarchy of power, the appearance of potentially competing centres of power (the court, the priests, the military, and provincial chiefs), and occupational differentiation. The state, with access to revenues or tributes and with the potential of commanding people provides a means for developments in crafts, trade, transport and warfare. The symbiosis between management and economic production in early states paved the way to future developments in practical crafts and hydraulic engineering.

## 4. The classical civilisations

### *4.1 The beginnings of hydraulic engineering*

The recurrence of large floods and droughts threatened food security and hence necessitated several developments which included, in addition to food exchanges between communities, local cooperative ventures to strengthen earthen banks, build dams, drains, and dig wells. With the emergence of state-level organisation some of the rulers undertook large-scale irrigation projects. However, there is no evidence that the emergence of centralised government was due primarily to co-ordinate irrigation activities on a national scale. Wittfogel's theory of 'Oriental Despotism'

(Wittfogel, 1957) which claims that the civilisations of China, India, Mesopotamia and Egypt depended on large-scale irrigation which led to the rise of despotic, bureaucratic, centralised states is untenable (for criticisms see e.g., Haas, 1982).

In the Nile Valley, the Egyptians made use of floodbasins for natural irrigation. Since floods came from the south and because the gradient of the floodplain slopes northwards, floodwater flowed northward from one floodbasin to another. Canals were useful in facilitating the flow of water from a floodbasin either back to the river, or to adjacent lower floodbasins to ensure that floodwater does not stay too long preventing sowing in time. On a local scale such water projects did not require management by a centralised government in the early stages of political evolution of the state. Initially, political associations depended primarily on the social integration and inter-community economic mergers to minimise risk at times of crop failure which any single community is likely to experience. Local variations in food yield between communities were common and unpredictable. Unexpectedly, a community may be faced by a breach in a levee, or shift in channel, or an excessive rate of siltation. There is no evidence in Egypt for a centralised management of irrigation. The state existed before any major water projects were initiated.

The first documented water projects in Egypt include a great wall constructed ca. 3000 BC to protect Egypt's first national capital, Memphis, from floods, and a dam dating to the Old Kingdom (2650–2150 BC), to harvest rain water from a wadi (Wadi Garawi) on the Nile bank opposite the capital. The last kings of the Old Kingdom were faced with political troubles and a declining level of Nile floods (Bell, 1970; 1975; Butzer, 1984; Hassan, 1997). At Memphis, the capital of the Old Kingdom, excavations clearly demonstrate the encroachment of wind-blown sand from the Sahara on a parched floodplain. The drop in Nile floods was rapid and traumatic. In a Papyrus now in Leiden, Ipuwer's poignant words recall such a calamity [extracts from a translation by Lichtheim (1973)].

Lo, the desert claims the land  
 The land is injured  
 Towns are ravaged, Upper Egypt became a wasteland  
 Lo, everyone's hair [has fallen out],  
 Lo, great and small <say> 'I wish I were dead'  
 Lo, children of nobles are dashed against walls,  
 Infants are put out on high ground  
 Food is lacking –  
 What does it taste like to-day  
 Wearers of fine linen are beaten with [sticks]  
 Ladies suffer like maidservants  
 Lo, those who were entombed are cast on high grounds

Men stir up strife unopposed  
Groaning is throughout the land, mingled with laments,  
See now the land is deprived of kingship  
What the pyramid hid is empty  
[The] people are diminished.

During a turbulent period of 150 years, Egypt was plunged into ‘chaos’ and social disorder. National unity disintegrated, and kings and dynasties were short-lived so that it was said in later times, that in one brief dynasty (the seventh) there were seventy kings in seventy days. The period of turmoil ended when Mentuhotepe II (2040–2010 BC), a king from Upper Egypt fought for national unity. In the course of thirteen years, he succeeded in his efforts and accordingly deserved the name Sematawy (‘He who unifies the Two Lands’). His successors included Senwosert II (1897–1878 BC) and his grandson Amenemhet III (1844–1797 BC), who had the foresight to embark upon Egypt’s, and one of the world’s, first ambitious agrarian project. The low floods and desert sand of the great drought had choked a minor branch of the Nile that supplied the Faiyum depression with water. The floods were also too low to permit water to overflow into the depression as it once did. The lake shrank exposing an immense area of cultivable land, but the water of the lake was at a lower level and brackish. Sesostris II embarked on the construction of an irrigation and a reclamation project. He built a dyke at el-Lahun, created a system of drainage canals, and re-established connection with Bahr Yusef to provide freshwater to the depression. The king himself oversaw the project and the royal necropolis, the holiest place of kingship, was relocated to the Faiyum at El-Lahun.

In spite of the activities undertaken by the kings of the Middle Kingdom, there are no indications that the main function of centralised government in Egypt or its bureaucracy was the management of artificial irrigation. In spite of references to occasional water projects in response to droughts, and the digging of local canals for drainage or irrigating uplands, the magnitude of water projects in Ancient Egypt hardly compares with the undertakings of Mohammed Ali in the nineteenth century. The centralised government in Egypt was more concerned with collecting taxes and attending to the monumental display of royal power and religious institutions than to irrigation. Basin irrigation on a local scale was more than sufficient to meet the needs of the early population of Ancient Egypt. Lloyd (Trigger et al., 1983) clearly states that ‘Large-scale crop cultivation relied at all periods upon the relatively primitive but efficient basin system of irrigation. This was organised at a local rather than a national level, but the ease and success of the process was always dependent upon the volume of the Nile which varied considerably in antiquity.’ It is noteworthy that the

Shaduf, a simple water lifting device was introduced during the New Kingdom, more than 1,500 years after the rise of Egyptian civilisation.

In Mesopotamia, the water levels of the rivers are at their lowest in the autumn, when the fields need to be flooded. This placed a premium on canal irrigation (unlike Egypt which enjoyed high floods in August in time for cereal cultivation). Not only was it important to control water flow and build regulators to raise the water level, but it was also necessary to work out a system of water rights. 'Canal Inspectors' (*gugallum*) were probably responsible for maintaining the canals by removing reeds and silt from the channel. The integration of the communities in larger social units created the potential of mobilising a greater work force. Large projects, such as the construction of a massive regulator were celebrated in formal inscriptions of the Pre-Sargonic rulers of Lagesh. After that period, redirection of the Euphrates and the Tigris are recorded in royal inscriptions.

In one of the earliest statements of a great water management project, the inscription of Rim-Sin I of Larsa (1822 BC) recalls this spectacular achievement (Postgate, 1992).

The eternal water, heritage of the land, the water which the Tigris and Euphrates had brought from of old, the spring flood which will never fail, the Mami-sarrat canal, the canal of abundance of the Land, carried away half the waters of the Tigris and Euphrates and poured them into the sea.

The Lord Nunamnir, whose word is important, turned towards the shepherd who pleases his heart: having called me joyfully, he decreed a good fate for me. Enlil, the Great Mountain, gave me the great mission of digging a canal to bring abundant waters to Sumer and Akkad, to make their extensive fields grow the dappled barley, to let the orchard wells increase the [...] of honey and wine, and to let their marshes joyfully provide fish.

On the banks I carried out the rituals. The towns and villages, the numerous people whose shepherds Enlil has given me, having assembled them from top to bottom [of the Land], I made them work by my great power. I fashioned the [canal's] two banks like awe-inspiring mountains. I established abundance at its mouth, and its tail I extended. I made the fresh grass thrive on its banks. I called the canal Tuqmat-Erra, and thus restored the eternal waters of the Tigris and Euphrates.

This great project clearly demonstrates the role of great rulers in mobilising a large labour force by their 'great power'. However, his great power, was already embedded in more than 1,200 years of elaborate state organisation. The power of a ruler was only as good as the power of the organisation he or she commanded, which depended primarily on a religious mandate or a pact of mutual interests between him/her and

regional rulers, regardless of whether his or her power was achieved by conquest or legitimate descent.

Water supply seems also to have been ensured, at least for drinking and perhaps irrigation of orchards, by narrow basins constructed alongside the canals. These reservoirs (*nag-ku(d)* were relatively small 15 to 2,700 m<sup>3</sup>). They probably served as reservoirs to tap water from the canals before it drains away to use it as a supplementary source of water. Farmers in the third and second millennium BC invested much labour in constructing and maintaining these reservoirs.

Irrigation is not without its problems. Evaporation following irrigation leads to the accumulation of salt under the summer heat of Mesopotamia. Poor drainage may also lead to a high water table and the deposition of salt below the surface under arid conditions. This would be aggravated during climatic episodes of droughts. Jacobsen (1982) has suggested that increasing salinity during the second half of the third millennium and later in the eighteenth to seventeenth centuries BC led to an almost complete abandonment of the major urban centres in the south. Although this may be an exaggerated claim, there is no contradictory evidence. Clearly, certain parts might have remained as cultivable enclaves. Also some communities with a better water management strategy might have fared better than others.

In China, the zone of the loess Highlands, where the tributary valley of the Wei, Fen, Lo, and Chin converge at the great bend of the Hwang Ho were the basis for the power of early dynastic powers (2200–1700 BC). Irrigation systems of these valleys, particularly the Wei Ho, supported a strong state with its capital in the Wei Valley at Chang'an. Later, new and larger irrigation systems widened the basis of revenues. The new developments shifted the economic base to the margin of the North China Plain at Loyang. By the time of the T'ang dynasty between the seventh and tenth centuries AD, irrigation projects shifted south into the Hwai River basin, the Red Basin of Szechuan, and then the Lower Yangtze. The Yangtze River (Changjiang) is the third longest river in the world. Its drainage encompasses about half of China's population and includes all the major agricultural areas of China – the Sichuan plain and the lower Yangtze, long regarded as the 'land of rice and fish'. The river is also navigable 600 miles from the sea as far as Wuhan by ocean-faring vessels, and by smaller boats to Chongqing. It thus served as a major transport artery for central China. Shanghai, at the mouth of the Yangtze, became China's largest port. The great economic potential of the Yangtze provided a strong economic basis for the T'ang Dynasty (618–907). The Yangtze was less turbulent than the Yellow River. Large lakes were natural means for minimising the impact of high floods (Chang, 1977; Keightly, 1983; Roberts, 1996; Gernet, 1985).

The Yellow River was subject to excessive fluctuations and flooding. It carried a heavy load of silt from the loess regions of the Northwest which caused excessive

build-up of the channels which now rise above the surrounding countryside protected by dykes. This river was the economic base of the Shang Dynasty (1700–1066 BC), a feudal agricultural society. Of seven warring feudal states, Qin state emerged as the first empire. Qin Shi Huangdi (221–210 BC) unified China into a hierarchy of prefectures and countries under centralised government. The Great Wall, joining previously built segments, was built to defend China against the Mongolian tribes. However, in the thirteenth century when the Mongols had all of China under their control, the Grand Canal was completed providing a major transportation and communication link (Chang, 1977; Keightly, 1983; Roberts, 1996).

In the northern Peruvian desert in the valleys from Moche to Lambayeque, the Chimú civilisation which flourished from AD 750 to 1450, depended on a system of raised irrigation canals. This northern zone was in its heyday, the most populous region of the central Andean coast. This desert is a coastal, low, flat, wide desert, nestled between the Andes mountains and the Pacific ocean. Both the river valleys and the inter-valley deserts were cultivated with the aid of irrigation networks. The canals were earthen or stone-lined aqueducts that carried the water from the mountains over the desert. Hydrological examination revealed that the canals were sound from an engineering point of view (Bruhns, 1994; Kosok, 1965; Netherly, 1984).

## ***4.2 Population, floods and droughts***

In spite of early hydraulic projects, the variations of climatic conditions bringing unanticipated catastrophic floods destroyed settlements and farms with a great loss of human life and livestock. These floods left an indelible mark on the minds of the early inhabitants of Mesopotamia as captured in the prototypical legend of Noah. In Mesopotamia, as in China, Egypt, and Europe in other times, farmers had to contend with repetitions of catastrophic floods. In China and India, the floods related to monsoonal discharge are particularly notorious. The situation is also made worse by the frequent recurrence of droughts, which were often combined with plagues. Worse still was the periodic occurrence of three or more successive years of droughts or floods. The impact of floods and droughts was profound in the agrarian setting because of its effect on food productivity. Villages located in or near the floodplain were also prone to destruction from violent floods.

The emergence of great civilisation is often associated with an increase in population. This appears to be mostly as result of the advantages of having a large labour force, since an increase in the labour force translates into an increase in the revenues to the rulers. Over-taxation, as a means of generating still more revenues, also compels the peasants to have more children that can share the burden of work.

This leads to an interesting paradox, as civilisations grow more affluent with great displays of works of art, monuments, and wealth, and even with great advances in agrarian technology, the peasantry are likely to grow poorer and work harder and longer. A rapid increase in population associated with great demands for defence, war to secure sumptuous goods, slaves, or raw materials, is likely to strain the balance between population and resources and render it vulnerable to droughts or floods.

Droughts, organisational problems, and large populations are surely at the heart of the woes of civilisations. The impact of population increase on human welfare is dramatically captured in the story preserved in a copy of Old Babylonian date. In the story, Man was created to relieve the gods from digging canals and agricultural labour. However, work on rivers and canals went so well, and plenty of food was produced for humans and gods alike. But consequently people multiplied so rapidly that after 1,200 years they have increased to such a magnitude that their noise and din disrupted the sleep of the mighty god Enlil ('the land was bellowing like a bull'). In consultation with the gods he sent a plague. People made offerings to Namtar, god of the plague, who repealed his act. However, after another 1,200 years people again multiplied and their noise was intolerable. Enraged, Enlil decided to send a drought. Adad the god of rain held back the rain. People hurried to offer prayers and gifts to Adad, who let the rain fall. Either oblivious to the cause of the plague and droughts, or unwilling to take sensible measures to control their numbers, they multiplied again and this time, Enlil and the gods, decided to cut off all nourishment from the people. Rain and floods were stopped, and Nidaba, the goddess of grain denied people cereal harvests. A sympathetic god, Enki, let large quantities of fish through to feed mankind (note here the cognitive and symbolic linkage between rain, drought, floods, and fish: fish survived as a symbol of plenty and prosperity in later beliefs). Enki, also forewarned a holyman, Atrahasis (Biblical Noah) who began to build a boat which he loaded with animals of all kinds in time to escape the flood that came raging over the land destroying everyone else in its path (Jacobsen, 1976). This Akkadian narrative post-dates an earlier Sumerian version. It is also re-told in the Gilgamesh Epic. In this great epic, Gilgamesh, the heroic ruler of Uruk encounters Utanapishtim in his search for the secret of eternity. Utanapishtim recounts to Gilgamesh the story of the flood – how he was warned by his God Ea, built an ark and saved his family and pairs of all animals, and how in recognition of having saved humanity and animals from destruction he was rewarded with eternal life.

The horrifying destructive role of successive droughts, when Enlil decided to withhold the rain is graphically told in the Old Babylonian story as follows:

The field cut down on its yield,  
Nidaba [the grain goddess] turned tail.

The black acres whitened,  
 The broad plain brought forth salt.  
 Earth's womb rebelled.  
 No plant came forth, grain pushed not through.  
 Infirmary befell people,  
 The womb was tied up.  
     could not speed the child out right.  
 [...]

When the second year arrived,  
 The looks of the people had changed out of hunger  
 When the fourth year arrived  
 Their long strides (?) grew short,  
 their broad shoulders had narrowed,  
 people walked in the street, hunched.  
 When the fifth year arrived,  
 a daughter (from her house)  
 would be seeing her mother come home,  
 (yet) the mother was not opening the door to the daughter.  
 The daughter was watching the scales of the mother.  
 The mother was watching the scales of the daughter.  
 When the sixth year arrived,  
 they served up a daughter for a meal,  
 served up a son for daily ration.  
 One house set upon the other.  
 Their faces were covered  
     as with dead malt;  
 the people hung on to life, having ceased breathing.

(Jacobsen, 1976)

The problem of excessive population increase in antiquity beyond the maximum limits of misery was countermanded by the practice of a variety of birth control methods. In the Babylonian account, Enlil was persuaded to agree to a birth control scheme to prevent humanity from over-multiplying. Some women were to become barren. Also several categories of priestesses were to abstain from having children.

In general, the current rates of population growth are unprecedented. A short life expectancy on average for adults (31–40 years), and a high mortality rates for infants placed a limit for rapid population increase well below the rates possible today as a result of the potential for a longer life expectancy for adults and greater survivorship for infants and children. However, it was still possible for a population to grow at a rate of 0.5 to 1% per year. But, long-term population growth rates were often minuscule (0.1–0.2 percent per year) as a result of random population oscillations



(including frequent depopulation), and the practice of population controls. After the advent of farming, the possibilities of rapid population increase were curbed by droughts and floods, and checked by deliberate population planning. Such methods included prolonged child nursing, delayed marriage (Plato recommended marriage at age 30 for males and 20 for females), abstinence, *coitus interruptus*, induced abortion, and infanticide. In ancient Greece, for example, family planning consisted mostly of exposing the new-born infants (Hassan 1981, 1999).

The limits to growth were imposed by the rate of economic growth, which were rather slow until the cumulative advances in global knowledge and technology reached a new threshold about five hundred years ago. Under pre-modern agrarian economies, communities in favoured localities numbered as many as 40 persons/km<sup>2</sup>. Such a density could have made possible a population of 32,000 and up to 40,000 persons from an area of 800–100 km<sup>2</sup>. Petty states in Mesoamerica and Predynastic Egypt were fairly limited in their territorial range, covering areas between around 100 to 400 km<sup>2</sup>. The consolidation of several regions in late Predynastic Egypt created units that covered 1,200–1,600 km<sup>2</sup> with as many as 20,000 to 30,000 people. The unification of Egypt led to the establishment of a state covering about 30,000 km<sup>2</sup> (Hassan 1993a, 1993b).

Empires after 1500 BC controlled vast areas. The Harappan civilisation covered an area of approximately 5.5 million km<sup>2</sup>. Imperial expansion was facilitated both by advances in water transport and construction of roads. The Inca Empire, between 1100 and 1400 AD, covering five times the area of Europe was linked together by a 16,000 km network of highways. Estimates of the size of empires reviewed by Sanderson (1995) indicate that there were three stages; from 3000 to 600 BC, 600 BC to AD 1600, and after AD 1600. During the first phase the Egyptian empire was 1 square megameter (one square megameter = 386,000 square miles) in 1500 BC compared with 0.45 sq. megameters in China at 1000 BC. Persia controlled an empire 5.5 sq. megameters around 600 BC. By 1300 AD, China had an empire as large as 15 sq. megameters.

A large population provides both economic and political power. The ratio of workers in a pre-industrial population ranges from 40% to 70% of the population. A unit that manages to achieve a population unit with as many as 40,000 people will have as many as 16,000 to 28,000 workers. The population will also include 10–15% male adults that can be mobilised as warriors, amounting to as many as 4,000 to 6,000 warriors. If all adult males were 'drafted,' that would provide perhaps as many as 10,000 warriors. A 'large' kingdom with as many as two million people could easily mount armies of 40,000 warriors, about 25% of all adult males. States that managed to control such a large population (equivalent to the size of Egypt during the Old Kingdom), other factors being equal, could conquer and dominate smaller states.

Large state societies can also afford to lose large numbers of warriors that can be replaced by warriors from other provinces.

Areas with naturally high productivity were more likely to achieve higher population density than others. This accounts for the rise of many early state societies in river valleys, such as the Tigris and Euphrates, the Nile, the Indus, and the Yangtze and the Hwang Ho. The rivers also provided the potential for water-transport, as well as a better overland transport network than mountainous or plateau areas. Certain settings and historical factors thus created a favourable environment for the emergence of people under state organisation. In Mesoamerica, about 35 million people occupied an area of one million km<sup>2</sup>. In China, the population is estimated at 60 million in AD 180 and 200 million in AD 1585. In Egypt, with a much smaller agricultural area (roughly 30,000 sq. km), the population is estimated at 1.2 million during the Old Kingdom (third millennium BC) and 3.2 million in Hellenistic times (Hassan, 1993a). By comparison, the population of the Roman Empire is estimated at 54 million.

### **4.3 *Cities and civilisation***

The emergence of cities soon followed the advent of farming. Cities were bound up with the immense productive potential of farming and the development of a system of government which commanded large aggregates of people over a large region. The story of civilisation over the last 3,000 years is inseparable from the increase in the number of cities and the expansion of world population.

The advent of food production provided a basis for establishing and maintaining large, sedentary communities. For two million years, our ancestors lived in mobile communities that numbered between 15 and 50 persons, with a breeding population of 500–1,000 person. The planet was populated at the dawn of farming by no more than 10–12 million peoples. The advent of farming, not only allowed rapid rates of population increase (with a long-term average of 0.1 percent per year), but also the establishment of year-round settlements. Initially, farming hamlets and villages consisting of 50–200 persons were followed by towns and cities. Urban centres were not primarily agrarian settlements, but centres of administration, religion, services, defence or trade. The evolution of the cities is closely tied with the emergence of rulers backed and legitimated by religious institutions. The rulers supported the import of exotic goods and the manufacture of luxury goods as a means of displaying and maintaining power. Exotic items and manufactured goods were used to reward chiefs and district governors, as well as priests and warriors. Maintenance of trade routes and expansion of trade led to the emergence of warfare and an expansion of commerce. Tradesmen eventually managed to displace divine kings, and taking

advantage of advances in transport and navigation succeeded in creating major trade networks that supported large cities. The cities also became the centres of technological advance and manufacture. The accrual of capital from commercial enterprises allowed investments in manufacture, which eventually led to the emergence of industry and a market economy.

As an example of early urbanisation, towns become visible in Egypt about 3650 BC. The emergence of towns seems to be related to the emergence of petty state societies with hierarchical social organisation. Towns were probably of two types; ritual centres associated with administrative functions by a ruling elite (e.g., Nagada South Town), and commercial centres that catered to the growing demands of the rising elite for goods related to funerary cults (e.g., Maadi, Hierakonpolis). The urban centres were small, but they hosted artisans and specialised craftspersons (Hassan, 1988).

Petty states were a step in a series of political transformations that ultimately led to the emergence of a nation-state ca. 3000 BC. In this process, unification of adjacent small states led to powerful provincial states. By 3300 BC, a kingdom encompassing the districts around Hierakonpolis, Nagada, and Abydos initiating a Protodynastic kingdom established a capital in Abydos. Following a merger with the Delta kingdoms, a new capital was established near Memphis. This process of unification involved military skirmishes and fortified towns are depicted on some of the palettes from that period. The emergence of new capitals relegated older capitals to lesser administrative functions or transformed them primarily into religious cult centres. Also, expansion of trade with the Levant, the development of seaworthy ships, and the growth of Delta ports such as at Buto became particularly important, perhaps overshadowing and leading to the decline of Maadi, which depended on overland trade. Towns were also established along the now defunct branches of the Nile leading to the Sinai. In order to supply the demands for funerary goods (a key element in a religious ideology that legitimated kingship), trade was an important factor in many Delta towns in the north and Elephantine in the south. The importance of local funerary cults linked to the royal cult in a syncretic cosmogony also perpetuated numerous towns as cult centres. These centres were linked to local administrative districts (nomes) and linked to the national capital by the river.

In the Valley of Mexico between 1500 and 600 BC, maize cultivators occupied the basins of small rivers. Their activities included building small canals, digging water holes, and levelling off the ground. The farmers exchanged their produce with fishers and hunters. Villages and towns appeared with monumental buildings and public spaces for ritual performances. The towns fostered the development of crafts and long-distance procurement of goods. A social elite was responsible between 600 BC and AD 300 for the development of planned cities at Cuicuilco and Tlapacoya. Public

places and avenues followed an urban design. The planning elite and priests lived in the palace-temple in the residential area and close to them were the manufacturers of luxury and export crafts. The rise of the cities was predicated upon the ability of the elite to coordinate and integrate four different farming systems around the administrative centres. The demands of the elite led to an intensification of production which was accompanied by the rise of complex ideological, managerial, bureaucratic, and military arrangements.

The emergence of Teotihuacán as a great city was a function of its location in a rich alluvial valley with a nearby lake stocked with fish and fowl. More importantly, the rise of the city was due to the policies of its elite who seized control of vast territories by violence and a commanding religious ideology. The city depended on a centralised management of specialised centres of production from its territory (Millon, 1973).

In general, pre-industrial capital cities consisted of no more than 20,000 persons, with many other cities within the range of 5,000 to 10,000 people. Large settlements before the state, for example from the Natufian to the Pre-Pottery Neolithic in the Levant, reached 300–450 peoples. In Egypt, the population of Tell el-Amarna was estimated at between 20,000 and 29,000. In Mesopotamia, the largest cities had between 12,000 and 34,000 persons; Ur had 24,000–34,000 inhabitants, Lagesh 19,000, Umma 16,000, and Khafaje 12,000. The population of regional capitals during the third millennium BC at Altyn-depe (26 ha) and Namazga-depe (50 ha) in southern Turkmenistan consisted of 5,000 to 15,000 people. In India, Mohenjodaro (200 ha) and Harappa (150 ha) consisted of 15,000–20,000 persons each (Hassan, 1999).

Examination of the size of the largest cities since 2250 BC reveals that about 40,000 persons was the minimum size of the largest cities until AD 1300. In 1300 BC, Thebes was a large city with 20,000–40,000 (Hassan, 1993*b*). The maximum size of the largest cities in 650 BC was 120,000 with a range from 400,000 to 700,000 between AD 100 and AD 1500. However, the maximum population of Rome in the late sixth century is estimated at 35,000–50,000. Census data of 103,000–152,000 for 508–392 BC of adult male citizens perhaps refer to the total population of Rome and its territories. It is likely that the, a resident population of 40,000 in ‘down-town’ Rome would have had about 280,000 within two or three miles from the city.

Cities also became larger by attracting or forcing farmers to reside within the city limits in order to secure access to food, to reduce cost, and to minimise the threat of siege or reduction of tributes. Teotihuacán increased from 15,000 to 125,000 in the Middle Classic Period by the displacement of rural settlements to the city. Lowland Maya cities included urban cores ranging from 13,000 to 75,000, with smaller centres consisting of 1,500–1,000 persons (Culbert and Rice, 1990).

Large cities were thus more the exception than the rule. This situation prevailed

until manufacture and trade in Europe allowed cities to expand. During the twelfth century, Milan may have had as many as 80,000 people. Of this large number, 20,000 were artisans. Most city-states consisted of smaller populations. Pisa, for example, consisted of 10,000 people.

The size of towns and cities was limited by the size of agricultural productivity, the limitations on the speed and load of transport, and the lack of professional armies. The emergence of professional soldiers in a later stage of state societies associated with investment in fast, military ships led to the rise of ancient empires in the Near East, Persia, Greece, and Italy. The territorial expansion allowed large cities to emerge.

Cities may develop in marginal habitats because of trade. Initially they may consist of small communities with enough resources to sustain them. However, as the number of people in the settlement increases, the utilisation of the local resources is intensified. In the wilderness of the Negev Desert, Napatean towns emerged along trade routes creating 'garden cities' with hundreds of miles of terraces and thousands of cisterns dug in the rocks exploiting and managing the scanty rain. Hundreds of rows of small stone mounds were constructed to deflect and collect raindrops and dew. However such settlements were at the mercy of trade. Under the Romans, the commercial and cultural importance of the Napatean towns dwindled (Hillel, 1994).

Commercial towns can be ephemeral as the towns that developed in East Africa along the Swahili caravan routes in the nineteenth century. These were towns where traders rested during the rains, replenished supplies, and gathered information. By contrast, commercial towns and cities that benefited from local agricultural productivity were much more stable and durable. Timbuktu, for example, not only had fresh water from the Niger, but also an abundance of agricultural products, cattle and milk (Connah 1987).

The emergence of large cities in early civilisations depended in part on maintaining a flow of food from a large population that ultimately depended on food production. Capital cities maintained access to the rural areas through large towns serving as urban centres of administrative regions. These towns, in turn, were surrounded by a cluster of smaller towns or large villages that served as markets for local produce and administrative posts.

The urban population in early state societies was a very small proportion of the total population. In fact, this was the case until modern urbanisation. As late as 1790, the urban population of the United States of America was no more than 5.1% of the total population. In pre-industrial societies, the urban population was often about 5%, and rarely as high as 8–10% of the population (Sjoberg, 1960). The Roman Empire, with as many as 54 million and an area of 3.33 million km<sup>2</sup>, would have had an urban population of 2.7 million.

The dynamics of growth were closely linked with power and sustainability. In Central Mexico, the growing material needs of the cities led to conquests until the conquered regions were quite distant from the capital. The outer provinces thus did not make a substantial contribution of foodstuffs which were much needed during the periods of food shortage. They provided instead prestige goods such as quetzal feathers, decorated blankets, and ceremonial costumes. The material requirements of Tenochtitlan spiralled as the city population increased in response to a relocation policy encouraged by imperial ideology. The demands of the growing aristocracy also spiralled as they drew more retainers, craftspeople, merchants, scribes, and concubines. This apparently led to a massive reclamation project and raised-field construction to supply perishable food-stuffs.

A city is a complex phenomenon. It is even more so because cities are likely to persist through time; once a city emerges it may become a fixed spot, a centre for the reasons that gave it birth in the first place, or because the social and cultural capital of the city gives it an advantage over other places. The survival of the city, however, leads to a growth phenomenon that lend to it patterns that are difficult to interpret because of spatial differentiation, expansion, and the emergence of different functions, or the disappearance of older functions. Changes in economy, religion, ideology or politics may favour the emergence of new urban centres that may in time eclipse older urban places, which may still persist as religious, national, or heritage centres.

A growing city faces severe water problems. Rome provides a prime example. The legacy of Rome before the age of empire is related to its position close to an important bridging point across the River Tiber formed by the Tiber Island. A bridge at that location made Rome an important centre for trade. The *pontifex* (bridge-maker) was such an important person that the name was appropriated by Christian priests later. The rise and fall of the Roman empire is significant because its military expansion was related to commerce, recalling the subsequent European 'age of exploration'. The defeat of the Carthaginians freed Rome (in the second half of the third century BC) from any serious military threat or commercial rivalry in the western Mediterranean.

With revenues from the far flung territories of the empire (including the great centres of ancient civilisation in Greece and Egypt), the population of Rome expanded into a great metropolis. Facing increasing water needs, Appius Claudius Craecus, was assigned the task of building the first aqueduct in 312 BC. He located water springs within five miles east of the city. A subterranean water tunnel, the Aqua Appia, ten miles long was dug providing sixteen million gallons of water per day. Forty years later, another aqueduct, the Aqua Anio Vetus, supplied water from the sparkling water of a lake on the Anio River. The tunnel extended over forty miles.

However, silt soon clogged the tunnel and water quality deteriorated. So in 140 BC, at great expense, a new aqueduct, Aqua Marcia, supplied Rome with water over a distance of 56 miles from the water springs of Subiaco. The aqueduct was elevated over arches and water was diverted into several branches. Emperor Marcus Aurelius Antoninus drew off a disproportionate share for his baths, which accommodated sixteen hundred bathers at any one time (Ashby, 1935; Anonymous, 1970; Biswas, 1970; Grimal, 1990; Winslow, 1963).

With growing population, crowding, as well as a rise in expected standard of living, water for public baths was in great demand. This necessitated the building of yet another aqueduct in 125 BC, the Tepula, from springs at the foot of the Alban Hills. The aqueduct was built on top of Aqua Marcia for the last six miles. Another aqueduct, Aqua Julia was later built on top to provide water to higher parts of the city. The enormous weight of the added stonework made the aqueducts vulnerable to storms and earthquakes.

Because demands for more baths continued to increase, a new aqueduct, Aqua Virgo, was built under Augustus in 19 BC. The water supply from this aqueduct was enormous. Every day, over 100 million gallons of water passed through the city, compared with a million gallons today in the River Tiber! Augustus also decided to build another aqueduct for irrigation, and used a part of the water to create an artificial lake, not realising that as a consequence that this area of the city became a habitat for the malaria-carrying anopheles mosquito.

Water came also into a different use under Trajan, again in a manner recalling the phase before the modern age of industry in Europe. Water from a new aqueduct, Aqua Trajana, was used to turn the wheels of many mills.

The building of aqueducts continued after the collapse of the Roman Empire, the last major aqueduct was completed in 1870 by Pope Pius IX. Ironically, it begins at the springs used for the first aqueduct, and is hence called Aqua Marcia-Pia. It is the oldest one still in use and is still one of Rome's chief sources of water.

Modern urbanisation (after AD 1650) is associated with the advent of industry and long-range, extensive commerce, backed by major financial institutions. Early urbanisation was based on manufacture or commerce – both were under the patronage of the king or the temple. Manufactured goods were for the state functionaries to be awarded by the head of the state. The expansion of manufacture and trade in later times were not only related to advances in technology, but also to the breakdown in the monopoly of manufacture and trade by divine kings, allowing many individuals to engage in such activities and raising the number of consumers by allowing commoners to have access to luxury goods. However, some early states generated income for the elite through manufacture and trade. In Teotihuacán, it is estimated that one-third of the population consisted of craft specialists. Commercialisation

during the Post-classic period in Mesoamerica was apparently linked with weak state control and the appearance of an autonomous and self-regulating economy after the collapse of powerful government.

In Europe, the development of medieval towns linked to trade and crafts in a climate of competition and warfare not only made it necessary to secure water for city dwellers, but also made use of water for defence, mills, tanners and paper-makers. Sewage, sanitation and water pollution became issues of concern, and had a major role in transforming water management methods (Guillerme, 1984; Goubert, 1989).

The concern for water in an urban context at a time when science was becoming a dominant mode of inquiry and a basis for action led to hydrological theories that made it possible to harness the energy of water for transportation and manufacture. Canals and water mills in the late eighteenth century paved the way to a world where water is controlled and manipulated.

The prevalence of a scientific outlook, however, was instrumental in alerting communities to the danger of deforestation and the drying of wetlands. Science also provided other means for manufacture that eliminated putrefaction and reduced the ravages of epidemics. With increasing affluence, the cities enjoyed the benefits of parks and tree-lined boulevards and fountains, the Renaissance legacy of a landscape of meadows, fountains and nymphs.

## 5. From medieval to modern

### 5.1 *After the Romans*

Invasions by nomadic herders led after AD 375 to the downfall of the Roman Empire in the west. Germanic tribal chieftains and kings ruled territories that were formerly Roman. The subsequent developments in the Mediterranean were shaped by the Byzantine Empire, marked by the transfer of power from Rome to Byzantium. Following a period of prosperity from 284 AD to about 610 AD in Late Antiquity, the Byzantine period lasted from the seventh century until 1453. Under Constantine, Constantinople replaced Byzantium as a Christian City, which became the great marketplace of the empire. Numerous fountains adorned the city.

The Mediterranean region was also re-shaped at that time by the expansion of Islamic civilisation to North Africa, the Levant, as well as Spain and Sicily. Towns in a vast empire linked the Mediterranean Islamic centres to a series of caravan and maritime routes reaching as far as India and China. The imprint of Islamic civilisation on the Mediterranean resulted from the initial conquests in the seventh and eighth century AD, and as a result of a series of European Crusades that succeeded in



establishing close links between the Muslim world and Byzantium. The Islamic connection was important in preserving and developing the intellectual heritage of Greece and Rome. It also led to the spread of advanced irrigation and water technology across the Mediterranean. The Muslims are credited specifically with three major irrigation techniques; 1) the use of dams as a method of raising water for diversion into irrigation canals, a method which dates back to early Egypt and Mesopotamia, and was used in Yemen for Marib Dam, 2) the *qanats* (*foggaras* in North Africa), first used in Persia (Wulff, 1968) or perhaps Armenia (Kobori, 1973), a network of horizontal tunnels which transported and distributed underground water to the surface by gravity, and 3) the *noria* (*Saqqyia*), a large wheel driven by the velocity of water current achieving a high hydraulic lift. In addition, a twin-cylinder, high lift device was developed using the first known true suction pipes. These developments are clearly manifest in the Iberian Peninsula, where *norias* are characteristic of Anadaluasia and Murcia. Islamic and later Christian Spain became a new centre for the diffusion of the *noria* (Schioler, 1973). Two well-known *qanats* are those of Madrid and Crevillene. The name Madrid, may actually be associated with 'matrix', source of water, since the city depended on a system of *qanats* (*viajes*) bringing water from the springs of the Guadarrama (Glick, 1970).

The Muslims also introduced two types of water mills (Bloch, 1969); the undershot which is a paddle wheel that turns under the impulse of the current, and an overshot type, which received water from above, often from specially constructed channels. In order to avoid low water levels during the dry season, the waterwheels were mounted on piers of bridges. Mills were used to grind corn, but were used for fulling of cloth, the crushing of ores, rice husking, and paper making (Faruqui et al., 2001).

The Muslim connection thus paved the way to the fundamental transformation of Mediterranean Europe into a world power since the tenth century AD. This transformation was also made possible by riverine navigation which was more efficient and cheaper than overland transport, especially for bulk trade. For example, viticulture was governed in medieval France by access to navigable rivers in the Seine, the Loire, the Garonne, the Rhine, and Moselle. It is for this reason, as at the time of early Rome, that bridge points became very important. These points became places for towns and urban settlements. Other favourable places for towns were at estuaries as seaports, the confluence of major rivers or tributaries, and junctions with overland roads. Inland water transport was also boosted after the coming of the steam engine in the mid-nineteenth century (Gladwin, 1973; Geiger, 1994).

## 5.2 *The collapse of civilisations*

Civilisations are fickle. They are subject to internal and external stresses. They evolve in

order to enhance food and water security, and in the process introduce new stresses. Farming, which provided the basis for civilisation, has an incredible economic growth potential in response to advances in irrigation, land use, fertilising, weeding, and the selection and breeding of crops are made. This kind of growth, however, is predicated upon managerial and technical developments. By agglutinating farmers from different communities and coordinating the exchange of food among communities, managers could enhance the overall security for all stake-holders. By amassing revenues, the managers could also invest in innovative technologies for added security. However, the emergence of powerful managers was accompanied with the ever-increasing demands for food (to be exchanged for manufactured goods, imports, and services). Managers also invested heavily in technologies of power, especially those related to religious establishments. They also supported other non-food producers who manned the tax collecting system and the maintenance of order. Differential wealth between communities, the expansion of trade, and the possibility of annexing other communities to provide labour and land made warfare a lucrative business (for a general discussion of the collapse of civilizations see Tainter, 1988).

Civilisations thus pass through stages of initial spurts of growth followed by a state of meta-stability as the 'expenditures' climb close to 'income' from farming beyond the subsistence needs of farmers. The options available to sustain growth, include 1) overtaxing the farmers which leads to weakened population at the brink of starvation and beset by disease and exhaustion, which may lead to rebellion, which in turn may lead to the deployment of a costly police force, adding another stressor to a metastable system which may hasten its collapse, 2) investing in a new technology or a managerial innovation, which requires funds that may not be available if the system has no savings to draw from, 3) warfare to annex others regions, which also adds the cost of maintaining an army and military hardware. Again, if a society cannot sustain the cost of military expenditure it will not be able to take this option. In addition, weakened societies are likely to be over-run by other military societies, which subsist from trade or nomadic pastoralism. It is noteworthy that the expansion of trade all around the coast of the Mediterranean which culminated in the commercial activities of Greeks and Phoenicians not only brought the Mediterranean region within a unified cultural domain, but also fostered the emergence of warfare as a means of solving conflicts among various groups. The Greek mercenaries created a new mode of livelihood that made it impossible for any group to shy away from military activities. It is also important to note that the rise of militarism circa. 500 BC in the Mediterranean region eventually led to the collapse of Egyptian and Persian civilisations at the hands of the Greeks. The Greeks were, in turn, routed by another military society, which enjoyed a period of dominance as a world empire before collapsing under the weight of its own military machine.

The Inca provide a case study of imperial expansion to satisfy the needs of the ruling class. They expanded until they ran out of civilised lands to conquer (Conrad and Demarest, 1984). According to Conrad and Demarest (1984), 'Despite its initial advantages, constant expansion soon began to strain Tawantinsuyu. In the first place, military campaigns were costly, and a ruler's quest for agricultural land had to be 'financed' by the rest of the empire. The army had to be manned by citizens fulfilling labour tax obligations, and it had to be supported by the produce of state-owned lands (not royal estates). Continual warfare required large investments of energy and resources and kept the demand for surplus production at a high level.' In expanding, the Inca armies marched on prepared roads and were accustomed to finding stored surplus foods to subsist on. They marched in massive formations, and fought with long range slings, darts, and bolas. However, after annexing all the civilised world around them, they ventured into the Amazonian forest and the heavily vegetated slopes of the Andes. Bringing to mind the fate of US troops in Vietnam, and the former USSR in Afghanistan, the Inca sustained heavy fatalities and their campaigns were unmitigated disasters. There were no roads, no visible villages, no stored food. The enemy was invisible and everywhere laying ambushes and sniping at them:

There were sudden and frightening attacks by enemies who, like unrestrained and undisciplined savages, ambushed [the Inca troops] at the worst possible moments. The enemy did not wait around to win or lose a battle. Their method of fighting was so disorderly that when the men of Cuzco wanted to attack, they could not find anyone to strike at; separately, each one on his own, the enemy vanished in the underbrush, where they could not be caught. In addition, [the Inca soldiers] were worn out by the wide and turbulent rivers that they found, the constant and vexing rains that fell upon them, the intense heat, the sweltering valleys through which they wandered, and the great hunger that they suffered.

Expansion through warfare was matched by investment in reclamation projects. Irrigation canal networks were extended into marginal lands. In the same manner the Romans reclaimed marginal deserts in Egypt and North Africa. These projects demanded a sizeable investment of labour both for construction, maintenance, and support. They also depended on the maintenance of a network of roads and a transport system to link them with markets and other sources of food. However, such marginal areas were more susceptible to crop failures because of administrative or natural causes. They were also not viable in the long run because of their limited fertility and their potential for salinization and loss of fertility due to soil erosion. For the Inca, terracing extended maize cultivation into the upper limits of the plant's range above 3,500 m in the south (2,700 m in the north). The potential for increasing

crops, was associated with increasing the chances for crop failure and erratic, unpredictable yield. In addition, fields reclaimed by canal construction were highly sensitive to variations in highland rainfall and runoff, the source of irrigation water for the arid coast.

Over-stretched civilisations are also likely to collapse if nudged by severe climatic variations over time. In addition to short-term fluctuations in the range of 10–15 years, climatic conditions are known to vary over several decades (30–40 years). The record of climatic variability also reveals not only a high-order scale of climatic change of approximately 1,700 or more, but also significant oscillations at a scale of 100–400 years. The changes are episodic (i.e., of variable duration perhaps reflecting an overlay and sum of cyclical as well as random variations of different scales). There are also abrupt, severe, and short-lived events that span decades to a century which were of local or continental significance (environmental proxies, e.g., pollen and sediments, vary in their ability to encode and/or preserve a climatic signal) which caused momentous cultural transformations, especially when such events were frequent and closely stacked. Such series of events occurred, for example, from 3300 BC to 2100 BC.

Accordingly, although civilisations may develop means to cope with perceived short-term fluctuations, they have no means by which to anticipate long-term oscillations. For example, the demise of the Harrapan civilisation was most probably caused by a combination of factors, not least of which were catastrophic floods. Layers of flood deposits as much as 23 m thick around Mohenjo Daro, and huge embankments as high as 9 m in elevation indicate that the city must have struggled with episodic flooding for some time. But it may well be that they were also plagued by droughts at the time at about 2200–2100 BC when climatic anomalies ravaged the Nile Valley and the Levant. The Nile and the Indus Valleys are influenced by monsoonal rain. The decline of the Harrapan civilisation coincided with the decline in the intensity of the Southwest monsoon. Sites of the phase following the Harrapan culture (characterised by Painted Grey Ware) are commonly located on the banks of the river indicating that the floods were too low to flood its banks (Bryson and Baerreis, 1967; Bryson and Murray, 1977; Bryson and Swain, 1981). Droughts would have also encouraged invasions by hungry pastoralists and might also have brought many plighted refugees to the cities. Failing to provide for the masses might have caused riots and civil unrest. By 2000 BC, the cities were showing signs of decline as squatter settlements were built on the ruins of earlier houses or on platforms to keep them above floodwater.

Another period of unstable climatic conditions occurred from the tenth to the thirteenth century. It is also now generally believed that the Chimú civilisation collapsed when a combination of El Niño torrential rains and earthquakes contri-

buted to the destruction of the elaborate network of irrigation canals. The demise of the Chimú civilisation and the collapse of the southern Tiahuanaco civilisation about AD 1200 coincide with this period of global climatic upheaval. The fragmentation of Tiahuanaco civilisation coincides with the emergence of the peoples of the southern Sierra (Fagan, 2000).

Large floods, as in the case of the Hohokam (AD 1 to AD 1450), destroy headgate structures and fill the canals with sediments. The Hohokam were prehistoric farmers who lived along the Gila River in Arizona and its tributaries from about AD 1 to 1450 were faced by frequent shifts in alluvial landscape. They constructed irrigation networks that were vulnerable to destruction by big floods and to change in alluvial landscape. In the American southwest, where farming depended on natural irrigation, communities suffered badly when channels were incised and deepened preventing water from flowing overland to the fields. For the Hohokam, large floods destroyed the headgate structures of canals, eroded the upper reaches of canals and adversely affected water supply to the canals. In response, collaborative efforts to maintain dykes and repair flood damage, along with collaborative effort to mitigate the impact of drought, engendered an ethos of both communal solidarity and management, eventually facilitating the emergence of leaders to coordinate activities and resolve disputes (Huckleberry, 1995).

The fate of the Hohokam at about the same time as the Chimú civilisation was a result of expanding agricultural production to a level of high risk and high cost, making it vulnerable to climatic perturbations. Here too, the eleventh century to fourteenth century climatic abnormalities seem to have brought about the collapse of the Hohokam. The Hohokam developed irrigation agriculture along the middle Gila River between AD 1 and 500. By AD 1000, following decades of population growth, social developments, and technological improvements, the Hohokam reached their zenith. Hohokam settlements expanded into the upper tributaries of the Gila Basin. A period of large flood frequency of the middle Gila river coincides with changes in architecture, burial practices, and settlement pattern. One of the key responses was a consolidation of canal systems along the middle Gila River. Instead of several independent canals, villages were connected by a single canal system from AD 1200 to 1450 (Huckleberry, 1995). The demands of centralised management, the cost of repairing the canal system, and the unreliability of food production in the extended parts of the system made it vulnerable to the erratic climatic conditions which prevailed at that time. The technological response (a single canal system) involved a high and expanding administrative and maintenance cost that in the long run undermined the short-term advantage of the technological fix.

Unlike other civilisations which emerged in arid lands, the Mayan civilisation developed in a tropical environment. It flourished in its tropical lowland area for

nearly 2,000 years before it collapsed in the tenth century AD. Where great pyramids and palaces once stood, a vast tropical forest engulfed the central Maya lowlands. The Classic Maya civilisation is not a physiographically defined area. It includes northeastern Peten, Guatemala, and southern Quinana Roo and Campeche, Mexico. The region is characterised by a zone of uplands interspersed with seasonally inundated depressions (*bajos*). Although there are various estimates of the population of the Maya lowlands, it appears that the maximum population reached 2.6–3.4 million with a density of 150 people per km<sup>2</sup> by AD 300. The spurt in population appears to have been related to expanding the subsistence base by developing levee or river edge cultivation using channels and raised fields, as well as swamp/bajo edge cultivation and steep slope and channel terracing. Sophisticated water management thus permitted a very high population density by comparison to the lower densities (10–50 persons/km<sup>2</sup>) possible under swidden agriculture (slash and burn).

However, by AD 950 the population declined to half a million and fell still further to eight thousand by AD 1850. There is evidently no strong documentation for soil degradation. It is also not likely that such a civilisation collapsed because of lack of control over a periphery that provided food. With no efficient means for long-distance transport of voluminous foodstuffs, the Mayans must have depended on food production from the core area (Turner, 1990). Given that global adverse climatic events have been documented from the tenth century to the thirteenth century, it is most likely that alternation of severe droughts and floods disrupted the sophisticated system of agrotechnology. The collapse was possible because the population was already at risk having expanded to a large number with little margin for recovery. In addition, the demands of the elite left little margin for safety. The raised canals, terracing, etc. by that time would have been more than several centuries old and perhaps more than a thousand years old and might have been greatly vulnerable to violent changes in rainfall and runoff regimes.

Although, the Mayan and Roman civilisations were manifestly different, the population of the Roman Empire suffered a decline during the first century AD. Here, as among the Maya, adverse climatic conditions might have abetted the decline of a fragile system of food production and distribution, as well as a differential appropriation of food in favour of the urban elite, not to mention the increasing demands of administrators and military generals and soldiers. Perhaps unlike the Maya, the inhabitants of Rome depended on food transport from the colonies, including Egypt. They clearly outstretched the limits of production, developing desert regions and maintaining elaborate systems of water management. In the process, they provided an incentive for population increase as a source of labour. An extended system of food production, with a high population density, and overtaxed peasantry is a system at risk. The social problems that would have aggravated the impact of droughts (for

which more evidence is still needed) are well attested in the description in AD 148 by Galen (cited in Newman et al., 1990).

For those who lived in the cities, in accordance with their habit of procuring sufficient grain at the beginning of the summer to last for the entire coming year, took from the fields all the wheat, barley, beans and lentils, leaving the other legumes to the *rustici*, although they even carted off no small portion of these to the city as well. Consequently, the peasantry of these districts, having consumed during the winter whatever was left were literally compelled for the rest of the year to feed on noxious plants, eating the shoots and tendrils of trees and shrubs, the bulbs and roots of unwholesome plants.

Clearly, the peasantry were at great risk if droughts happened, especially if they came in a series of two, three, four, five, or six years, as they occurred. At such times, morbidity is likely to be combined with civil unrest, violence, and cannibalism. Depopulation could reach catastrophic limits, as in medieval Egypt, thus depriving the city dwellers, the military, and the royal elite from the revenues essential for their power and survival. These are also the times when nomads (regarded as barbarian by civilised folk), similarly affected by droughts or taking advantage of the opportunity, are likely to invade and annex weakened, demoralised, and fragmented kingdoms and empires.

### **5.3 Modernity and its discontents**

In Europe, the industrial urban revolution was the result of the breakdown of the monopoly of the king and Pope over commerce and the rise of *commerçants* and financiers, as the holders of *real* power and the brokers of power *politick*. The *commerçants* gained to benefit from the manufacture and selling of 'industrial' goods at a massive scale. In contrast to 'king and pope', who used trade items and a limited edition of prestige goods as a means to control and manipulate power enlisting support or rewarding loyalists. The king or pope satisfied their desires for food, concubines, music, intellectual discourse, and sports by securing revenues from a broad base of peasants who tilled the land. They exchanged food for the work of artisans, artists, soldiers, and other services and then exchanged the products of services or manufacture for yet other services.

Merchants succeeded in usurping power from European monarchs and the church in the wake of the Arab wave that shattered the pre-existing social order and made accessible to 'commoners' secrets of navigation, warfare, and scientific methodology. The compass, the geographic maps, the numerals, ship building, optics, the emphasis on observation, logic, and experiment were clearly among the fundamental pillars of the commercial-industrial-military complex that paved the way to the rise of

the West. In the meantime, the Moslem East was seized by separatist movements, dogmatism, and vitiated by the Turks who lost the bid for outpacing the West. With the death of Suleiman (the Magnificent) the 'Orient' began its decline as a global superpower.

Cities such as Venice, Genoa, and Florence emerged as centres of power derived from trade. In other parts of Europe many towns serving as places for fairs and commerce also developed into urban centres. The profits from trade can far outweigh the 'profit' from farming. Traders thus tend to float to the top. Not unlike, and certainly in imitation of royalty, successful merchants could afford to acquire the external trappings of power and invest in public monuments and 'charities' to impress, mollify, and justify their activities and riches.

The role of rivers in unifying a country may be illustrated by the role of rivers in France during the eighteenth century as trade expanded. Connected by rivers, the patchwork of French regions was stitched together and boundaries between separate provinces were disappearing. The flow of traffic along the major waterways, the Rhone, Saone, Garonne and Dordogne, the Seine, and its tributaries, and the Loire was considerable. The Loire was particularly significant joining north and south, east and west. It was connected by portage to the Rhone. Canals also linked it to the Seine and Paris. The Rhone and the Saone ran along the very axis of the French Isthmus, in a straight line from north to south. The Rhone was a great convenience for those who wished to go to Italy by way of Marseille.

From this perspective, it is perhaps an accident of historical development that has so far allowed Europe to maintain its hegemony since its growth was associated with the emergence of a middle class who opted to reduce their family size in order to increase their standard of living. This 'middle class', made possible because of the breakdown of the monopoly of the Church and the monarchy on trade, facilitated the use of a 'surplus' in maintaining a formidable war-making machine. Nevertheless, the hegemony of Europe and the industrial world in general, depended on the threat or physical use of warfare in an unequal appropriation of resources. The rest of the world became, in essence, a pauperised peasantry who were not just literally compelled to feed on meagre diets, but also to desire and have large families in order to meet the increasing demands for taxation, and to take advantage of a marginal profit from work in plantations or industrial developments in their countries. Industries were often located in cities, to which rural, pauperised peasants emigrated to become pauperised labourers. However, the cities provided opportunities of work and advancement thus encouraging further migrations and population increase both in the cities and the countryside. The result is that the world has lurched in no more than 90 years from 1900 to 1990 from 1.6 billion to 5.33 billion, doubling in size during the last forty years.



Decolonisation did not significantly change the situation because the economic disparity, and structural pattern of hegemony has not altered. Shifts have consisted mostly of altering the hegemonic controls from overt military presence to political dependency (reducing the cost of a standing army and colonial administration!) and shift in the centre of military and economic power from Europe to the United States of America and the former USSR, and more recently, the fragmentation of the USSR, and the emergence of Germany and Japan as new centres of economic and political power. Countries in Africa, the rest of Asia, and the Americas are still struggling to meet rising expectations for a good life (modelled after the West as presented in the media) and provide for the demands of their own elite. Having more children to put on the farm, send off to the city, or try to put one or more of them through college in order to increase family income and potential security, continue to encourage a large family size and a spiralling world population. We are already witnessing the dangers posed by an overgrown population. This is not simply the sickening sight of starved children and emaciated corpses, but it is also a threat to peace, security and stability in the world.

The West, not unlike Rome, depends on the population in the periphery for its prosperity, if not in food, certainly in the resources necessary for the manufacture of the goods that are the source of income through sales to the Western middle class and the burgeoning middle class in other countries as well. With weak governments abroad, a result of faltering infrastructure after decades of colonisation, competition for power that often leads to autocratic military rule and a succession of overthrowing governments by violence, the West not only intervenes to sustain the flow of resources from these countries and to keep the markets open through aid programmes, but it also intervenes militarily whenever warranted to maintain the 'peace' and 'stability' required for orderly economic transactions. Western powers keep also developing enough military power to deter others from displacing them from the ranks of the first world. Under such conditions we have good reason to be fearful of droughts under adverse climatic conditions or scarcities introduced by inequities. A system at risk, because of military over-expenditure, can easily collapse if slightly nudged.

In the meantime, the cost of high productivity and the impact of billions of people on the habitats of the Earth are causing a noticeable strain. The problem is not as much one of numbers but of ecological stewardship and global economy. To wave the threat of 'overpopulation' or continue to reiterate pro-natalist policies encoded in early agrarian state ideologies is short-sighted. Nine months after Hitler came to power in 1934, his ruthless suppression of abortion led to a sudden rise of birth rate at 4 points per 1,000 (Pressat, 1971). Policies that still adhere to a view of having more people as a means of increasing state power and the labour force ignore the economics and politics of the present. The population dilemma lies today in the

divergence between the objectives of the state and the family. In addition, there is a legacy of a pronatalist ethos that has victimised women in the past. Ironically, women were valued only as ‘mothers.’ Women are also caught in the cycle of poverty related to population growth. Greater demands on natural resources lead to environmental degradation which leads the poor to depend on child labour to maintain a living. This contributes to population growth which in turn contributes to greater poverty.

Industrialisation benefiting from the colonial possessions not only created an array of desirable consumer goods, but also more effective means of increasing agricultural yield. Either in order to improve one’s station in life or to evade punishment or murder, more children were procured to fuel the industrial machine. Most of this increase was not a result of better health conditions, but primarily a consequence of reducing or eliminating cultural population controls. Where health ‘improvements’ were made, they were mostly in reducing infant mortality. Many women in many Third World countries still die at a young tender age as did their grandmothers hundreds of years ago.

## 6. Past and current problems

### 6.1 *Despotism or social justice*

Our journey as an animal species is rather short and curious. Having appeared no more than 100–60,000 years ago from an ancestry that was more ape than man five million years ago, we are late comers in the 500 million years history of life on earth. Yet we have multiplied in such a short time to more than 6 billion creatures, and had invaded and inhabited a wide range of habitats from polar deserts to hot tropical forests. We owe this to our genetic propensity to sociality and to our capacity for intelligent thinking. From the beginning the ability of members of our ancestors to band together in defence against predators and to share food resources was our ticket to evolutionary success. From parental care to empathy, our ancestors created a social milieu that fostered communication and facilitated sharing information and innovations. The ability to learn, to imagine, to remember and to construct anticipatory models of beneficial and harmful actions are the hallmark of our spectacular ability to overcome adverse environmental conditions. Society provided a collective memory and a sense of history and direction. As a species we are not only one biologically, but we are also the beneficiaries of a cultural inheritance passed down to us from our predecessors from China to Patagonia. We share the invention of fire, the alphabet, the moral principles, and the musical instruments.

Our sense of morality and fundamental notions of ethics are deeply rooted in our distant past. It is a result of applying our intelligence to harmonise our relationship with others and nature to sustain ourselves. In as much as our existence and welfare depends on others, social values are at the heart of human societies. The particular elements of morality in any given society, however, depend on a combination of historical and cultural contingencies, and vary depending on the size, mobility, modes of substance, and managerial mode of social organisation. Historically, the advent of agriculture created unprecedented social conditions, and was hence critical in the formulation of human moral values that have endured until the advent of mechanised industry during the last 200 years.

Agriculture in the broad river valleys encouraged not only permanent settlements, but also the emergence of cooperative communities of large numbers. Clusters of communities huddled together in villages. Daughter hamlets were spawned off distributing the population over areas of different potentialities and liabilities. As agricultural failures due, among other things, to unpredictable fluctuations in floodwater afflicted some communities, a social revolution was to follow. Communities developed agreements for mutual aid and help, extending the ethos of sharing – common among their hunting-foraging-within-bands ancestors – to their new situation applying it to sharing *between* communities. As sharing networks became more complex and extended, they were managed by notable members of the corporate group. Their task was to arbitrate and resolve disputes or conflicts that were likely to arise when obligations may not be honoured. Disputes over water rights were likely to be among the sources of irritating conflicts between households within the same community and between neighbouring communities, as it is still the case today.

Integrating neighbouring communities was a successful gambit. Not only did it contribute to the preservation of relatively large, sedentary groups of peoples in small regions, but it also contributed to minimise the survival risk of any individual communities. The greater the number of communities entering a corporate contract the greater their chances of survival in face of the disasters of crop failures. Normalisation of organisational principles and the solidification of the role of moderators as corporate leaders and chiefs was a first step toward the eventual development of princes and monarchs.

The monarchs differed from their predecessors in the scope and function of their duties. They commanded large areas with a multitude of communities. Accordingly, their rule could not be legitimated solely by kinship. The king himself became the embodiment of an ancestral figure that bound all the communities together. From him flowed the past. His powers were also well beyond those of the mortals as he was the living son of ancestors that belong to the world of the spirits and supernatural forces. Rather than a bureaucratic manager, the king's role in maintaining the multi-

ethnic communities under his reign was the divine embodiment of their unity in a supernatural being. The great empires of China, for example, were not so much a result of works of irrigation under centralised management, as the result of a machinery of bureaucrats and scholars, as well as powerful armies.

Despotism and coercion belong to a later stage in the development of civilisation and the rise of the state. They are the by-products of the transition from a state based on a household model, in which the ruler was a head of the family, to a state based on the integration of different peoples within a territory, when kinship is not the primary social bond. Coercion also belongs to a stage when managers accumulated enough wealth to reward and bind to themselves loyal lineages, clans, functionaries and warriors. The accumulation of wealth is not possible without the initial integration of many communities, which provide revenues to a manager. Such managers are initially selected for the benefit of everyone for their ability to resolve disputes, heal social wounds, provide a common ideological vision, and arrange communal rituals, celebrations and festivities.

Unification and integration was often achieved in early civilisations by the help of religion. For example, fundamental to the success of Liu Pang, who succeeded in uniting China under the Han dynasty in 202 BC, was the establishment of a state religion. In this religion, as in the state religion of ancient Egypt before, the sole purpose was to glorify the power, majesty and divine authority of the monarch and his role in the maintenance of cosmic order. The monarch was 'Son of Heaven', as the pharaoh was the son of cosmic gods. Again in the seventh century under the leadership of the house of T'ang, the unique prestige of the ruler as 'Son of Heaven', which has been tarnished by the disintegration of the Han Dynasty at the hand of foreign invaders. The revitalisation of the state religion and bureaucracy created a strong unified state. The potential for the emergence of a great civilisation in China in the first place and the possibility for restoring and expanding this great civilisation was undoubtedly based on the great agricultural potential of the Yellow River Valley and later the great plains irrigated by the Yangtze River.

The success of the government depended on maintaining the allegiance of the vassal lords who controlled parts of the basin, its ability to squash rebellion, and its capacity to defend the ruling dynasty against its competitors from inside and outside. River basins were unified more by temples than torture (the latter, nevertheless was an effective alternative). Authority could have never, and had never been maintained by coercion except briefly. Even if peasant revolts could be crushed, excessive taxation and oppression leads to desertion, morbidity, and premature death thus depriving a government of its labour force. In ancient China, as in Egypt under the Ottomans, droughts and over taxation led to insurrections.

In the long run social justice was the only viable alternative as it has been

repeatedly demonstrated. Even the Roman emperors eventually had to cut back taxes and introduce economic reforms. Laws and wisdom of justice reverberates throughout the ages from Hammurapi to Suleiman [the Magnificent], from Buddha to Martin Luther King, as a constant refrain to empires.

The good kings maintained peace by supplying water to those in need. This is evident from Gudea cylinder (c. 2230 BC), which gives details of the construction of the Eninnu, the principal shrine of Ningirsu at Girsu in order to appease the god and rescue Lagesh from the effects of a water shortage (Postgate, 1992).

When for me able shepherd Gudea,  
 You have started (work) on Eninu, my royal abode,  
 I will call up in heaven a humid wind,  
 that shall bring you abundance from on high,  
 so that in your time the people shall spread their hands on plenty.  
 Prosperity shall accompany the laying of the foundations of my house.  
 All the great fields will raise their hands for you,  
 dikes and canals will crane their necks for you,  
 and for you the water will rise  
 to the high ground which the waters do not reach.  
 Cream will be poured abundantly in Sumer in your time.  
 Good weight of wool will be given in your time.

The state is always put to the test when droughts lead to famine as grain supplies dwindle. During the first 200 years of the Han Dynasty in China (206 BC–AD 220), droughts and harmful floods struck no less than twenty times. People were forced to sell their children, kill their infants, and resort to cannibalism. Similar events occurred in Egypt during the tenth to the early thirteenth century AD and again during the eighteenth century AD during the Fatimid and Ottoman periods, when recurrent droughts led to famines forcing people to eat dogs, donkeys, and children. The famines combined with the plague, led to the death of hundreds of thousands of people (especially when merchants and the rich inflated grain prices thus aggravating food scarcity).

The 'Son of Heaven' in Tang China, the Ensi in Ancient Sumer, or the Pharaoh in ancient Egypt made offerings and performed rituals to avert disasters. In China, at the time of the visit of Marco Polo, it was the custom if grain supplies failed and the government refused to alleviate the problem for the peasants, to legitimately attack higher authorities and seek redress. This is clearly expressed in the following Ch' In Chia (600 BC Song 194, Stanzas 1 and 3).

Vast and mighty Heaven,  
Why withhold thy goodness,  
Sending down death and famine,  
Ravaging the four quarters of the land,  
Great Heaven, in thy majesty,  
Why no concern, why no plan?  
Regarding not the guilty  
Who have suffered for their crimes,  
Why are the guiltless  
Swallowed up in wide calamities?  
Why mighty Heaven,  
Does the king not hearken to righteous words,  
Like one wandering afar  
Unknowing of his goal?  
Let all those in authority  
Attend to their proper conduct.  
If they fear not other men  
Have they no fear of Heaven?

The tendency to abuse power was often curtailed by the popular resistance as in the numerous cases of peasant revolts, and strikes and violent confrontations following the advent of industry. Although, coercion and other means of persuasion were used to diffuse dissatisfied peasants and workers, co-existence between different segments of society requires mutual consent and an accommodation of the needs of the under-privileged masses. In an industrial context, reforming the workplace and other social reforms by 1850 were necessary to prevent violent outbreaks and a continuation of social turbulence.

In antiquity, social movements emerged to prevent the tyranny of those in power. These movements were often associated with episodes of droughts and famines which aggravated the plight of the poor. Mo Tzu (480/465 BC to 390/375 BC), who lived at a time of social strife and chaos in China advocated social equality and social utility. He adverted that love should be alike for everybody. His principle of all-embracing love was initiated to prevent the great harms in the world:

... attacks on small states by large ones, in-roads on small families by large ones, plunders of the weak by the strong, oppression of the few by the many, deception of the simple by the cunning and disdain toward the humble by the honoured.

In his teachings, Mo Tzu extolled the virtues of the great Yu, legendary founder of the

Hsia dynasty (c. 2205–c 1766 BC). It is interesting that Yu's claim to greatness lies in his success in coping with a devastating flood. His water management scheme was not only for the benefit of his own people, but also of all others in the river basin. Yu was also noted for his self-sacrifice and devotion to duty.

A few centuries after the death of Mo Tzu, in the final days of the Roman empire, the hardships experienced by common people led them to flock to salvation religions and oriental cults, as happened earlier in the Hellenistic East. Christianity promising salvation and the hope of personal resurrection following that of Christ was the most successful. Constantine made the decision to adopt Christianity as the state religion in order to establish stability and cohesion. The common people were promised a release from suffering. 'I bring you tidings of great joy which shall be to all people', declared the saviour. Christianity promoted the idea and practice of brotherly love, self-denial, and mutual help. Their meetings were called *agape* (love in Greek).

At the time of the late Hellenistic period and the Early Republic in Rome, and following the invasion of India by Alexander the Macedonian, a young general, Chandragupta, seized power and expanded his rule from the Ganges to the Indus, including the rich deltas of both rivers. His son, Ashoka (273–232 BC) conquered eastern India thus ruling over the whole of the Indian peninsula except for the southern tip. The king obtained one sixth of the harvest (about 17 per cent), which in practice was raised to a fourth (25 per cent), not including revenues to the local administrators and soldiers. The peasants were left with little to sustain them. Ashoka also had to maintain a standing army of 700,000 soldiers with 10,000 chariots and 9,000 elephants to keep the empire intact. Following a battle in which 100,000 prisoners were killed he was moved by profound sorrow and regret. As a result he tried to apply the teachings of the Buddha and ruled with great popularity for forty-one years. He regarded as his duty, the good of the whole world.

Clearly by the first millennium AD, humanity has developed principles of social justice and equity for all. The masses could and did appeal to these principles that were passed from one generation to the next as the moral legacy of humankind. It is such principles that underlie the notions of human rights and are used to hold rulers and the powerful accountable.

## **.2 Justice in action: canons and codes of water ethics**

The idea that it was the ruler and his officials who were morally and practically responsible for droughts and natural disasters and the consequent misery suffered by the people was canonised by Confucius. In the cities of antiquity, water supply suffered less from technological inadequacies than from social disparities.

The ordinary citizens in the cities of the Roman empire were not favoured by adequate water supply. In the capital, despite the aqueducts, piped running water, marble-adorned lavatories in the public baths, no water reached tenement buildings. Water had to be brought by water-carriers. Sewage was discharge down in sewage drains or cess-trenches, which were not proofed against seepage.

The Roman people consisted of an aristocracy, the citizens (peasants), and slaves. Rich landowners appropriated most of the water for their private baths and gardens. The River Tiber provided water for the poor. The lives of the poor were not particularly easy during the troubled times of Caligula and Nero. Claudius, eventually murdered by Nero's mother, forced new legislation through the senate for the benefit of freemen, slaves, widows, and orphans. Nerva, averting civil revolts during the turbulent years when emperors were assassinated in rapid succession, cut taxes. He also appointed Sextus Julius Frotinus, a masterful manager. His investigations as water commissioner revealed that the department was heavily involved in bribery and graft. Some areas of the city were without water because conduits were broken or in disrepair. To him we also owe the great work *De Aquis Urbis Romae*, a highly informative technical report. Not only did he deal with engineering and construction issues, but also with the laws and penalties that governed the use and maintenance of the aqueducts. He introduced a law requiring water users to obtain licenses. Water licenses could not be inherited. Heavy fines were levied for making any breaks in channels, conduits, arches, pipes, tubs, reservoirs or basins. Fortinus' reformations doubled the supply for the city in a few years. Roman laws also dealt with water claims and obligations of 'rivals'. That very word in Roman law denoted those who shared the water of a *rivus*, or irrigation channel. It implies jealously guarded rights and frequent disputes.

The problems of the cities, of disparities in distribution, and lavish consumption of water, are coupled with those of the farmlands. It is erroneous to assume that state societies were responsible for a centralised administrative direction of hydraulic works. Mediterranean peoples, for example, have consistently adopted certain principles reflecting the need for co-operation. These concepts range from those first spelled out in the code of Hammurapi to the institutions of medieval Valencia.

Hummurapi (1792 BC), King of Babylon, whose rule encompassed the entire Tigris Valley, and that of the Euphrates as far as Mari. instituted a strong managerial code; each man must keep his own part of the dyke and ditch system in good repair, and in default must recompense the neighbouring farmers whose land has suffered by flooding.

High water comes in April in the Tigris, and about a month later in the Euphrates, which has further to come from melting snow. When the floodwater comes, the land is protected by a series of regulators. The carelessness of even a single farmer in con-



trolling the flow of water from a canal could easily have disastrous effect on neighbouring fields, washing away the elaborate furrow system and quite likely uprooting crops. Hammurapi's code is clear about the obligations of farmers:

If a man has opened his channel for irrigation, and has been negligent and allowed the water to wash away a neighbour's field, he shall pay grain equivalent to (the crops of) his neighbours.

If a man released the water and allowed the water to wash away the works (i.e., furrows and soil preparation) on a neighbour's field, he shall pay 10 gur of grain per bur.

Royal letters to governors also show that each district was responsible for the upkeep of its own canals. To the governor of Larsa, Hammurapi wrote, 'summon the people who hold fields on this side of the Damanu canal, that they may scour it. Within this present month let them finish it.' In another letter he complained that the bed of a canal was not perfectly cleared, so that boats could not enter the city of Uruk.

Several millennia later in medieval Valencia, principles for water use included (Glick, 1970):

1. The principle of proportional distribution: the cultivator receives water in proportion to the amount of land he works.
2. The concept of individual responsibility to whole communities of irrigators; each irrigator has specific responsibilities for the upkeep of canals, submitting to rules for water use, and is liable for damages caused to neighbours.
3. The principle of collective responsibility for the apportionment of water and policing irrigation arrangements. Local irrigation authorities are usually members of the community of irrigators and rarely appointed from outside. Recourse to higher organs of justice is only in case of appeal.

These principles provide a basic historical ethical code for freshwater use in antiquity. Another fundamental principle, which is essential for conflict resolution in a dynamic society is the concept of irrigation districts (*huertas*) in Valencia. In common law the *huerta* has a fixed limit which is a function of the optimum service area for the city's water resources. The water of a public river ought to be divided in relation to the size of the possessions irrigated. New water uses should not deprive lands cultivated since olden times from their crops. Canals should not be built or widened to reduce the amount of water irrigating pre-existing lands. Expansion should thus not be at the expense of pre-existing water users. In Valencia, the expansion of irrigation cultivation due to economic and demographic factors was countermanded by climatic and political management. Following a period of expansion from 1238 to 1321, catastrophic droughts prompted legal actions by the king and the destruction of new works and a return to 'Islamic' concepts of limits.

And again, following another cycle from 1321 to 1413, expansion was terminated by a long drought and a political solution imposed by the city of Valencia (Glick, 1970).

Today as in the past, with the prospects of droughts in Spain and elsewhere around the Mediterranean, and with increasing domestic, agrarian, and industrial demands for water, it is prudent to reassess current policies in terms of public policies toward expanding water use beyond the ecological thresholds of disaster, no matter how tempting are new technologies. It would also be prudent to consider our obligations to those whose claim to clean water comes before expanding industries and the luxuries of elite urban life.

### ***6.3 Water in a global society***

In the past, the common good was restricted to particular human groups or communities beginning with the band of huntas and culminating in the nation-state. We are now at a new juncture in our evolutionary adventure. The advances in long-distance intercontinental transportation, as our ships and planes criss-cross the planet in hours, allow both people and goods to conquer the habitual fixed coordinates of human existence. This has engendered a new global economic order that has begun to undermine the economic privileges once protected by the nation-state. A new world has also been created by the instantaneous transmission of information by electronic media. Cyber-space, a veritable time-machine disseminates news with remarkable speed that would have taken months or years to travel in the past. Information and the transportation revolution have made our world an interdependent, interactive whole – our common good can no longer be that of a tribe, a Greek polis, or a nation-state, but of the whole of humanity. The new ethic is not to be invented but is to be re-introduced from our historical past and extended to others who share with us the bond of humanity, the deepest and most fundamental bond we ever had.

For thousands of years, far greater than the span of 200–300 years of ‘modernity’, world civilisations have experimented with numerous models of morality and have in the process discovered, in a variety of forms, moral principles that have been elevated to axioms and maxims, ideals by which a society must strive to achieve in order to minimise suffering, ensure harmony, and, provide, where scarcities and chaos prevail, a sense of dignity, endurance, and hope. Religions and the literature of wisdom by prophets and sages in China, India, Arabia, and Europe, have for ages advocated ethics of sharing, compassion and empathy. These are ethics of obligations, not of property rights, or free market inequities. Social justice is not simply a function of utilities of individuals, but of the common good, which is a function of the relationships, interactions, and interdependency among people, as in a family. Such common

good is also inter-dependent with nature in as much as our common good is inseparable from the fertility of the land, the purity of water, the roar of waterfalls, and the murmur of mountain brooks (Gustafson, 1983).

The common good of humanity is bound up with the well-being of our planet. An oil spill, industrial pollution, pesticides, deforestation and the ozone-destructive gas emissions, no matter where they are, pose a threat to the integrity of our climate, and our vital resources, including water. We do not have to slip into 'nomadic primitivism' or a mystic adulation of nature to concede that we have to recognize our interdependency with nature and the mutual links that now bind us together: to damage nature is to tighten the noose around our necks.

Our world has become rigidly divided among sovereign nation-states with strictly guarded borders and chauvinistic ideologies. It has become obsessed with technological fixes, and fevered consumerism. It has lost its connectivity with nature, and has atomised communities in celebration of rambunctious individualism. It has banished the sacred and placed profit above the joy of life and the tranquility of mind.

We have in our long evolutionary interaction co-evolved: the nature is within us, and we are an integral element of its complex web. From the moment our ancestors began to make fire, use a digging stick, or shoot an animal, nature was no longer independent of our actions. With farming, invented some ten thousand years ago, we began in earnest to fell trees, change the course of rivers, and regrade hillsides. Today, our impact is both global and dangerously calamitous. A new water ethic must include a rehabilitation of our valuable water resources.

Water has been a symbol of life, purity, and regeneration in many civilisations and religions. It was celebrated, by a king who aimed to unify his people by proclaiming and affirming creation by one god. Although, he chose the Sun (Aton) as his supreme deity, Amenhotep IV, who changed his name to Akhenaton (The spirit of Aten), the imagery of water as manifest in the Nile and its bounty, as well as the 'Nile in Heaven' ('rain' for other peoples) was beautifully expressed in the following hymn (Lichtheim, 1976):

You made Hapy *in dat*,♦ You bring him when you will,  
To nourish the people,  
For you made them for yourself.  
Lord of all who toils for them.

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♦ *dat* is the netherworld, *Hapy*, the god of inundation, *Aten*, the Sun-god.

Lord of all lands who shines for them,  
 Aten of daytime, great in glory!  
 All distant lands you make them live,  
 You made a heavenly Hapy descend for them;  
 He makes waves on the mountains like the sea  
 To drenching the fields and their towns.  
 How excellent are your ways, O. Lord of eternity!  
 A Hapy from Heaven for foreign peoples,  
 And all lands' creatures that wlak on legs,  
 For Egypt the Hapy comes from *dat*.

The provision of water from a new spring in the drought-stricken desert is always a miracle, which is celebrated in the biblical story of Abraham. To this day, the water of the spring-well, *Bir Zamzam*, is sacred to the Moslem pilgrims who make certain to drink from its sweet water.

The secularisation of society in Europe, which has been since the seventeenth century a major element in re-shaping the minds of Europeans and the political regimes in Europe has been critical in de-emphasising notions of the sacred (regardless of its association with divinity) in favour of notions of worldly profit and success. Water, an iconic medium of the sacred, is now to become a 'commodity'. It is not that water has not been regarded in the past as a marketable good, but it is the novelty of treating it strictly as a 'commodity' subject to market speculation, inflation, supply and demand, and profit-making enterprises. Societies elevated certain life-support substances to the realm of the sacred: bread, water, salt, and milk. The sanctification of these substances is grounded in their life-giving properties. As a minimum of social sharing, and indeed as an expression of social bonding, people would 'eat bread and salt' together and would share water as a sign of being one together.

Instead of destroying one of our most enduring symbols of life and hope in the name of combating what is flaunted as a water crisis, it would seem more prudent, and certainly ethical to deploy water symbolism as a means of unifying humanity, and redressing its gross managerial problems.

From an archaeological retrospective on earth resources and population, published in 1983, it occurred to me that 'Humanity is now at the end of its tether. It faces for the first time since the struggle for human survival by our ancestral forms in the savanna of Africa, a challenge to its existence as a life form. Sharing and cooperation saved the day in the dim part of the Pleistocene. It is this very element of human culture that still holds the key to human survival today. The world has become not only a global village ... but the inhabitants of the earth also have become a global band who face the same danger and must exploit the same resources' (Hassan, 1983).

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